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**BEATTY SECONDARY SCHOOL
END OF YEAR EXAMINATION 2021**

SUBJECT : SCIENCE (PHYSICS - CHEMISTRY) **LEVEL : Sec 3 E / 3N SBB**
PAPER : 5076 / 1 **DURATION : 1 hour**
SETTER : Mrs Seah & Ms Jamie **DATE : 11 October 2021**

CLASS :	NAME :	REG NO :
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READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use staples, paper clips, glue or correction fluid.

Write your name, register number and class on the Answer Sheet in the spaces provided.

There are **forty** questions on this paper. Answer **all** questions. For each question, there are four possible answers **A, B, C** or **D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will **not** be deducted for a wrong answer.

Any rough working should be done in this booklet.

A copy of the Periodic Table is printed on page 17.

The use of an approved scientific calculator is expected, where appropriate.

This paper consists of **17** printed pages.

[Turn over

- 1 A micro-organism's length is 20 nm. What is its length in metres in standard form?

A 2.0×10^{-9} m **B** 2.0×10^{-8} m **C** 20×10^{-9} m **D** 2.0×10^{-10} m

- 2 Which row correctly shows a scalar and a vector quantity?

	scalar	vector
A	acceleration	velocity
B	displacement	speed
C	mass	density
D	time	force

- 3 Two objects X and Y are identical in size and shape but X has 3 times the mass of Y. They are both released simultaneously from a point 100 m above the ground.

Below are some statements regarding the motion of X and Y.

- 1 The rate of change of velocity is the same for X and Y as soon as they are released.
- 2 Both X and Y will reach the same terminal velocity.
- 3 X will reach the ground before Y.

Assuming no air resistance, which statement(s) is/are true?

A 1 only **B** 1 and 3 only **C** 2 and 3 only **D** 1, 2 and 3

- 4 An Eskimo is pulling a sledge across level snow. The sledge has a mass of 25 kg. The Eskimo pulls with a horizontal force of 60 N and the constant force of friction is 20 N.

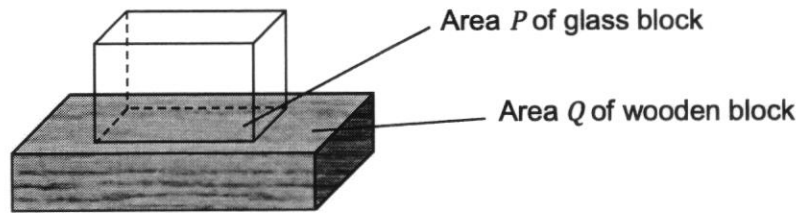
What is the acceleration of the sledge?

A 0.080 m/s^2 **B** 0.625 m/s^2 **C** 1.60 m/s^2 **D** 1.80 m/s^2

- 5 Which person has the greatest inertia?

- A** 50 kg girl sprinting at 10 m/s
B 70 kg marathon runner running at 2 m/s
C 90 kg National Serviceman jogging at 5 m/s
D 110 kg boxer resting on a bench

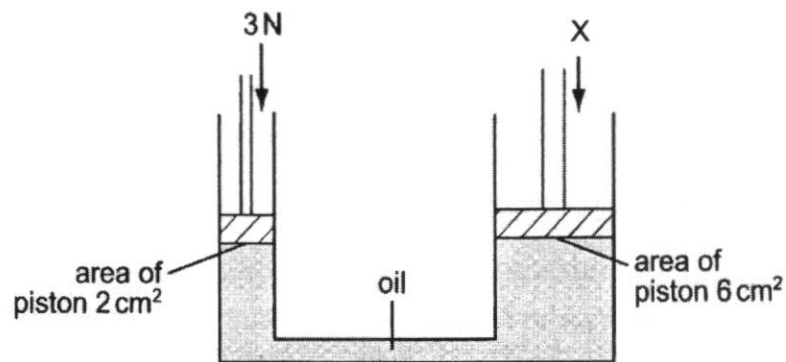
- 6 The diagram shows a glass block resting on a wooden block.



The area of the glass block in contact with the wooden block is P and the area of the top of the wooden block is Q . The weight of the glass block is W and the weight of the wooden block is X .

Which expression gives the pressure exerted on the glass block by the wooden block?

- A $W \div P$ B $W \div Q$ C $X \div P$ D $X \div Q$
- 7 Two closely-fitting smooth pistons are connected as shown below. What is the force X necessary to balance the system?



- A 1.5 N B 3.0 N C 6.0 N D 9.0 N
- 8 Which description suits the animal that is less likely to live in muddy terrain?
- A big feet and has big volume
 B big feet and has small mass
 C small feet and has large mass
 D small feet and has small mass

- 9 When the Brownian motion of smoke particles in air is observed with a microscope, moving points of light are seen.

Which description about these points of light is correct?

- A air particles moving randomly B air particles vibrating
C smoke particles moving randomly D smoke particles vibrating

- 10 A fixed mass of gas is expanding while kept at constant temperature.

How do the properties of the molecules of the gas change at the same time?

	average speed	frequency of collision with walls	average distance apart
A	increases	decreases	increases
B	increases	increases	decreases
C	unchanged	decreases	increases
D	unchanged	increases	decreases

- 11 Which statement about the kinetic model of matter is true?

- A All matter are made up of tiny particles that are closely packed and vibrate about their fixed position.
B All molecules in solid, liquid and gas move at the same speed.
C At higher temperature, gas molecules move faster and change direction more frequently.
D Solid particles are constantly moving around at high speed.

- 12 During a barbecue, why do we always cook food on top of the charcoal?

- A To increase the rate of heat transfer by conduction.
B To increase the rate of heat transfer by convection.
C To increase the rate of heat transfer by radiation.
D To increase the rate of heat transfer by radiation and convection.

- 13 What property of the particles decreases when a solid becomes a liquid at its melting point?

- A attractive forces between molecules
B average kinetic energy of the molecules
C molecular mass
D molecular spacing

- 14 Electromagnetic waves of wavelength λ and frequency f travel at speed c in a vacuum.

Which pair of values describes the wavelength and speed if the electromagnetic waves frequency is now $0.5f$?

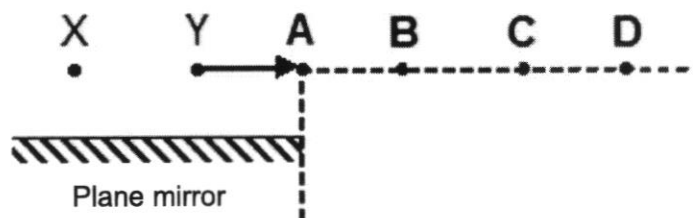
	wavelength	speed in vacuum
A	0.5λ	$0.5c$
B	0.5λ	c
C	2λ	c
D	2λ	$0.5c$

- 15 Which statement best describes the common property of visible light, X-rays and radio waves?

- A** They can be used in telecommunications.
- B** Their frequencies are lower than that of microwaves.
- C** Their wavelengths are shorter than that of microwaves.
- D** They travel with the same speed in vacuum.

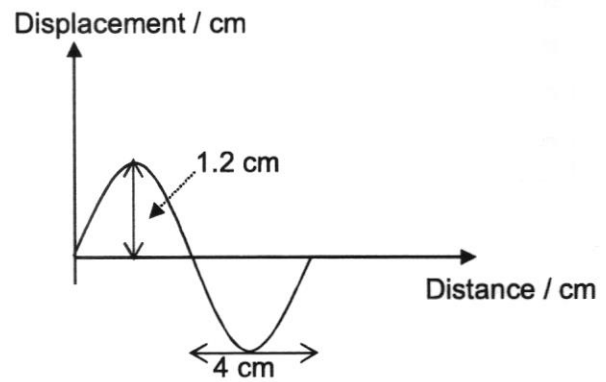
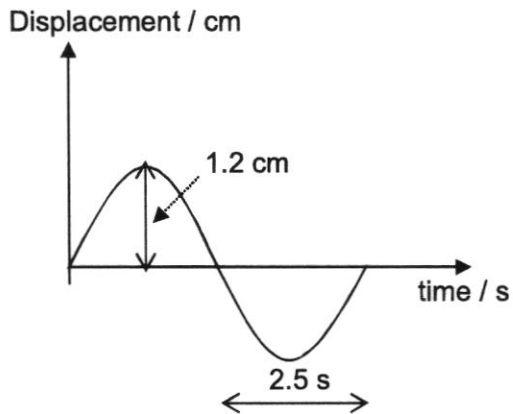
- 16 Two people are standing at points X and Y in front of a plane mirror as shown in the diagram below. They see each other through reflection in the mirror.

If the person at Y walks away from X in the direction of the arrow shown, which of the points is the furthest position he can walk so that the two people will still be able see each other by reflection in the mirror?



- 17 The displacement-time graph and displacement-distance graph of a wave are shown in the diagrams below.

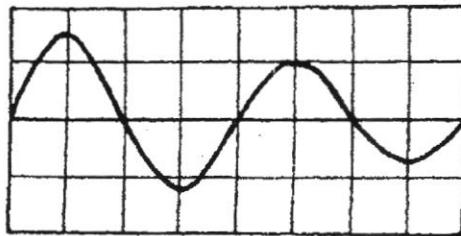
What is the speed of the wave particle?



- A 0.48 cm/s B 0.96 cm/s C 1.20 cm/s D 1.60 cm/s

- 18 The waveform of a note from a piano is shown below.

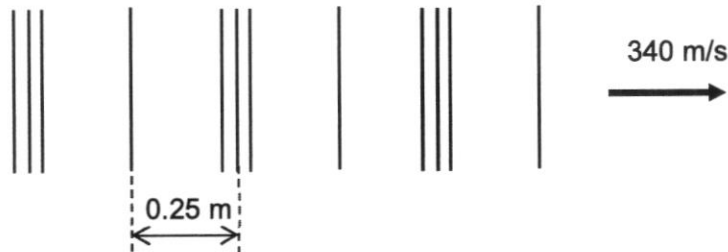
Which row of descriptions about the loudness and the pitch of the note is correct?



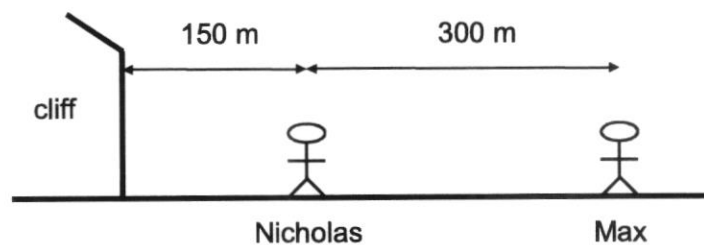
	loudness	pitch
A	decreases	decreases
B	decreases	remains unchanged
C	remains unchanged	decreases
D	remains unchanged	remains unchanged

- 19 As a sound wave propagates at 340 m/s, regions of compressions and rarefactions appear. One typical waveform is drawn below.

What is the frequency of the sound wave?



- A 85 Hz B 170 Hz C 680 Hz D 1360 Hz
- 20 Nicholas fired a gun 150 m towards a cliff. Max who was standing another 300 m further away from Nicholas heard the gunshot 1.0 s after he saw the flash.

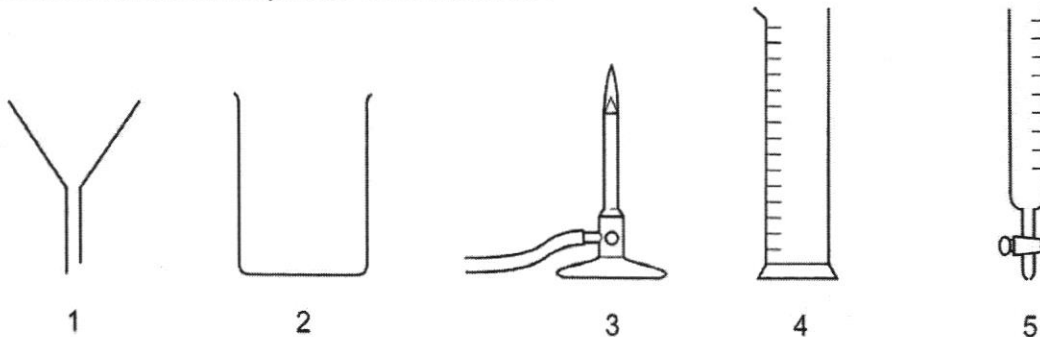


When will Max hear the echo?

- A 1.0 s after seeing the flash. B 2.0 s after hearing the gunshot.
C 2.0 s after seeing the flash. D 3.0 s after hearing the gunshot.

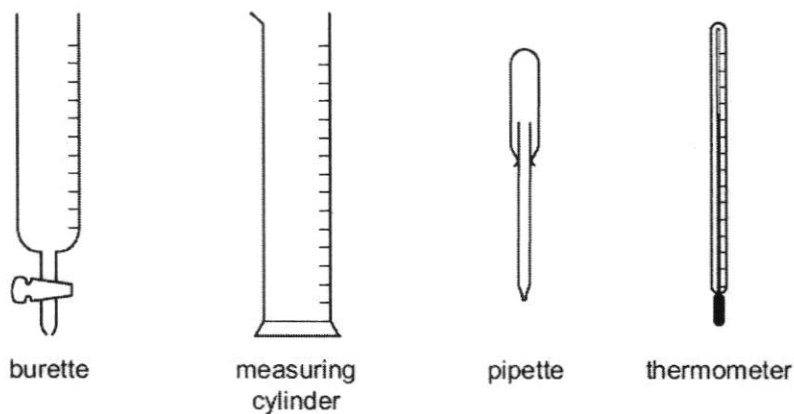
- 21 Strontium sulfate is an insoluble salt. A student, Alexis, attempts to make strontium sulfate by adding approximately 21.0 cm^3 of aqueous strontium nitrate to aqueous sodium sulfate.

Which pieces of apparatus are needed by Alexis to obtain solid strontium sulfate from aqueous strontium nitrate and aqueous sodium sulfate?



- A 1, 2 and 3
 B 1, 2 and 4
 C 2, 3 and 4
 D 2, 3 and 5

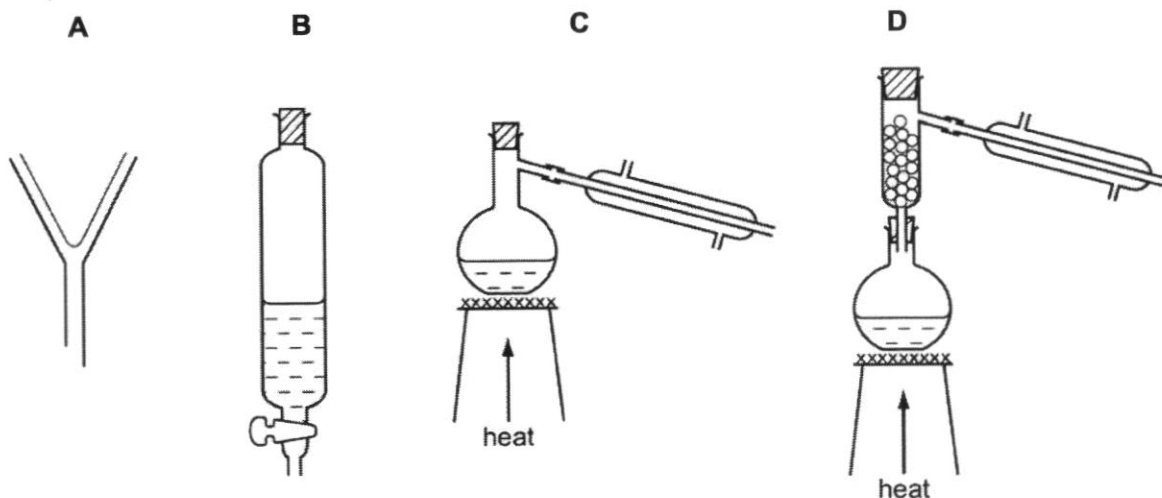
- 22 The four pieces of apparatus shown below are used in chemical experiments.



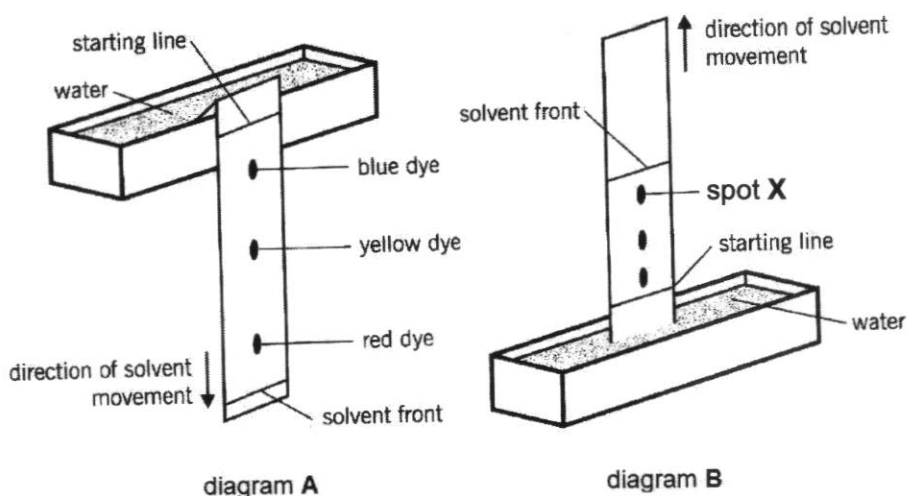
Which statement about the apparatus is correct?

- A The burette can be used to measure 17.30 cm^3 of solution to a flask.
 B The measuring cylinder measures the mass of a substance used in an experiment.
 C The pipette can be used to add 25.10 cm^3 of liquid to a beaker.
 D The thermometer collects and measures the temperature of a water-soluble gas.

- 23 Butane and hexane are two liquids that can mix together. How can a mixture of these two liquids be separated?



- 24 Diagram A shows a descending paper chromatography and diagram B shows an ascending paper chromatography.



Both experiments are used to separate the same sample of ink for two minutes. The distance between the starting line and the solvent front in Diagrams A and B is 5 cm and 3 cm respectively after two minutes.

Which statement about these experiments is **not** correct?

- A Blue is the least soluble in water in descending paper chromatography.
- B The ink sample is made up of three different substances.
- C The substances move faster in descending paper chromatography because they are more soluble in this setup.
- D The spot X is the red dye.

- 25** Annabel accidentally dropped some very tiny diamonds into copper(II) oxide powder.

Copper(II) oxide powder dissolves in acid but not in water while diamonds do not dissolve in either.

What steps should be used by Annabel to recover the tiny diamonds from the mixture?

	step 1	step 2	step 3
A	shake with water	filter	evaporate the filtrate and crystallise
B	shake with water	filter	evaporate the filtrate to dryness
C	shake with dilute sulfuric acid	filter	collect the residue and wash it with water
D	shake with dilute sulfuric acid	filter	collect the filtrate and wash it with water

- 26** A mixture of manganese(IV) oxide powder and sulfur powder may be separated by the procedure below.

Step 1 : The mixture is added into carbon disulfide and stirred.

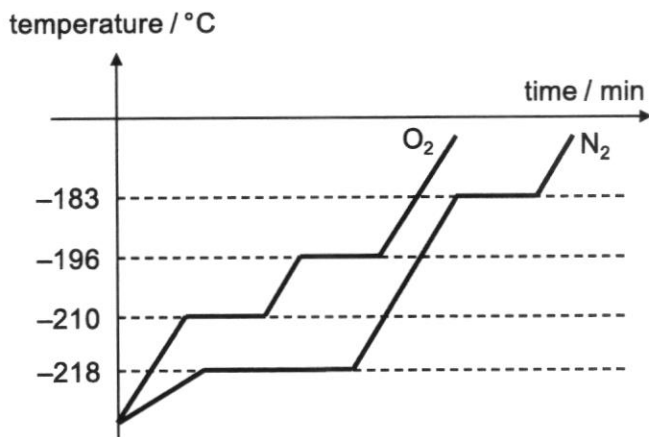
Step 2: The resulting mixture is filtered.

Step 3: The filtrate is distilled to recover the sulfur. The distillate is condensed using tap water.

Which statement cannot be deduced from the above procedure?

- A** Carbon disulfide has a low boiling point.
 - B** Manganese(IV) oxide does not react with carbon disulfide.
 - C** Sulfur is stable to heating.
 - D** Sulfur is soluble in carbon disulfide.
- 27** Some brown powder is placed in a test tube. Water is added and the tube is shaken. The contents are filtered. A black solid is left as the residue. After evaporating the filtrate, some orange crystals are seen. The experiment suggests
- A** the black solid is an element.
 - B** the brown powder is a compound.
 - C** the brown powder is a mixture.
 - D** the orange crystals are a compound.

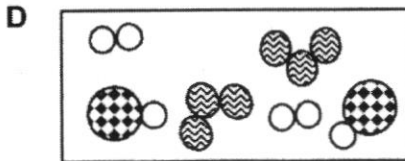
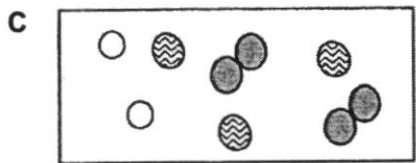
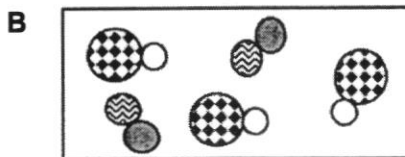
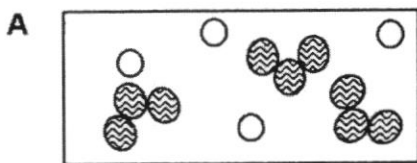
- 28** The graphs (*not drawn to scale*) show the heating curves of oxygen and nitrogen over a period of time when a mixture of oxygen and nitrogen is heated.



At what temperature will oxygen be in a **different** state of matter as compared to nitrogen at the same time?

- A** -180 °C **B** -215 °C
C -200 °C **D** -220 °C

- 29** Which diagram represents a mixture of element(s) and compound(s)?



- 30** Buckminsterfullerene was discovered in 1985 by a group of scientists. The formula of buckminsterfullerene was found to be C_{60} .
From this information alone, we can deduce that buckminsterfullerene

- A** contains only one element.
B is a mixture of 60 atoms.
C is a mixture of 60 elements.
D is a compound made up of 60 atoms.

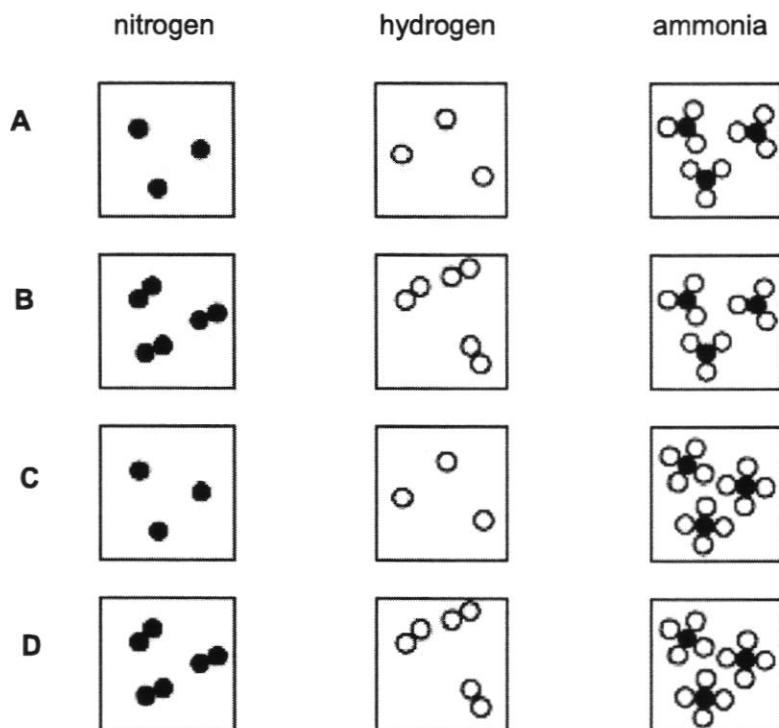
- 31 The table below contains details of four different particles. The letters are not chemical symbols.

	K	L	M	N
nucleon number	3	14	19	23
proton number	2	7	10	11
total number of electrons	2	7	10	11

Which of the particles K, L, M and N will form an ionic compound with chlorine?

- A Particle K
- B Particle L
- C Particle M
- D Particle N

- 32 In the Haber process, nitrogen and hydrogen react to form ammonia. Which set of diagrams represents the molecules of nitrogen, hydrogen and ammonia?



- 33 Uranium has two stable isotopes X and Y.

Which row of the table correctly compares the relative masses, atomic numbers and densities of X and Y?

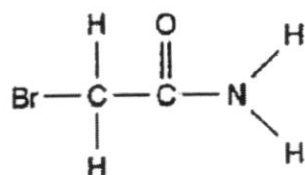
	relative masses of X and Y	atomic numbers of X and Y	densities of X and Y
A	different	same	different
B	different	same	same
C	same	same	different
D	same	same	same

- 34 The table below shows some of the physical properties of two unknown substances, P and Q.

unknown substance	melting point / °C	boiling point / °C	electrical conductivity of		solubility in water
			solid state	molten state	
P	122	550	poor	poor	insoluble
Q	690	1790	poor	good	soluble

Which statement about the two substances is correct?

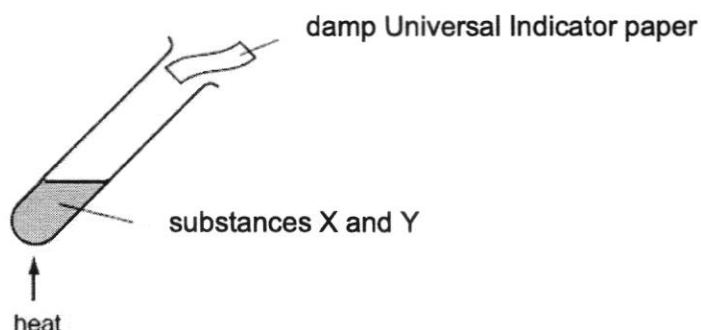
- A Substance P is a simple molecular compound with weak ionic bonds.
 B Substance P is a covalent compound made up of a metal and non-metal.
 C Substance Q is an ionic compound with mobile electrons in the molten state.
 D Substance Q is an ionic compound that is held together by strong forces of attraction.
- 35 The structure of a molecule is shown below.



How many outer shell electrons of the atoms are **not** involved in covalent bonding?

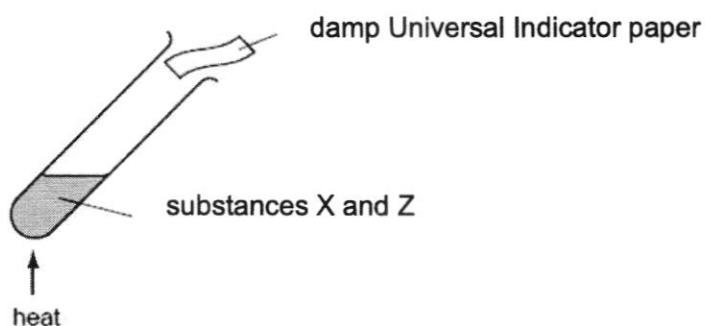
- A 6
 B 10
 C 8
 D 12

- 36 The diagram shows two substances, X and Y, being heated together.



The Universal Indicator paper turns blue during the experiment.

The next diagram shows two substances, X and Z, also being heated together.



The Universal Indicator paper turns yellow during the experiment.

What are substances X, Y and Z?

	X	Y	Z
A	ammonium carbonate	hydrochloric acid	sodium hydroxide
B	ammonium carbonate	sodium hydroxide	hydrochloric acid
C	sodium carbonate	hydrochloric acid	sodium hydroxide
D	sodium carbonate	sodium hydroxide	hydrochloric acid

- 37 Sodium hydroxide is commercially made into a soap known as lye. 2.00 g of the lye required 60.0 cm³ of 0.500 mol/dm³ of HCl to neutralize it. What is the percentage of sodium hydroxide in lye?

- A 20.0%
- B 40.0%
- C 60.0%
- D 80.0%

- 38 The following statements were made by some students about acids, bases and oxides.

student	statement
Caitlin	All metals can react with acids to form a salt and hydrogen gas.
Freya	All carbonates react with acids to form a salt, water and carbon monoxide gas.
Sarah	Alkalis are insoluble bases.
Si Jia	Amphoteric oxides react with acids to form salt and water but do not react with bases.
Tanisha	All acid-base reactions form the ionic equation: $\text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O}$
Wei Wen	An example of a neutral oxide is nitrogen dioxide.

Which student(s) is/are correct?

- A Caitlin, Freya and Tanisha
- B Caitlin, Sarah and Si Jia
- C Freya, Tanisha and Wei Wen
- D None of the above

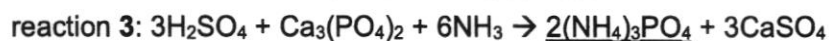
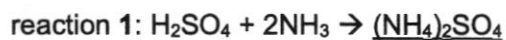
- 39 The following chart shows the range of colours across pH 1 to pH 14 for the indicator Thymol blue.

pH 1	2	3	4	5	6	7	8	9	10	11	12	13	14
bright pink		orange		yellow					cyan blue		dark purple		

Which statement is correct?

- A Distilled water has the same colour when Thymol blue is added to it and when Universal indicator is added to it separately.
- B Dilute sodium hydroxide and sodium chloride solution will show the same colour when Thymol blue is added to these samples separately.
- C Dilute potassium hydroxide has the same colour when Thymol blue is added to it and when Universal indicator is added to it separately.
- D When a few drops of Thymol blue is added to a sample of nitric acid, the colour of the indicator will be orange.

40 Below are the overall equations for the manufacture of three fertilizers (*underlined*).



Mr of H_2SO_4 : 98;

Mr of $(\text{NH}_4)_2\text{SO}_4$: 132;

Mr of $\text{Ca}(\text{H}_2\text{PO}_4)_2$: 234;

Mr of $(\text{NH}_4)_3\text{PO}_4$: 149

In each reaction, 98 tonnes of sulfuric acid was used. Which reaction gave the greatest, and which the least, mass of fertilizer?

	greatest mass	least mass
A	reaction 1	reaction 2
B	reaction 1	reaction 3
C	reaction 2	reaction 1
D	reaction 3	reaction 2

~ End of Paper 1 ~

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The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).



**BEATTY SECONDARY SCHOOL
END OF YEAR EXAMINATION 2021**

SUBJECT : SCIENCE (PHYSICS)

LEVEL : Sec 3E / 3N SBB

PAPER : 5076 / 2

DURATION : 1 hour 15 minutes

SETTER : Mrs Seah

DATE : 6 Oct 2021

CLASS :	NAME :	REG NO :
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READ THESE INSTRUCTIONS FIRST

Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A

Answer **all** questions.

Write your answers in the spaces provided on the Question Paper.

Section B

Answer **both** questions.

Write your answers in the spaces provided on the Question Paper.

Candidates are reminded that **all** quantitative answers should include appropriate units.
The use of an approved scientific calculator is expected, where appropriate.
Candidates are advised to show all their working in a clear and orderly manner, as more marks are awarded for sound use of Physics than for correct answers.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [] at the end of each question or part-question.

For Examiner's Use	
Section A	/45
Section B	/20
TOTAL	/65

This paper consists of **14** printed pages (including this cover page)

[Turn over

Section A (45 marks)

Answer **all** the questions in this section.

- 1 In Fig.1.1, the bob of a simple pendulum is swinging between X and Y. It took 1.5 s to go from X to Y.

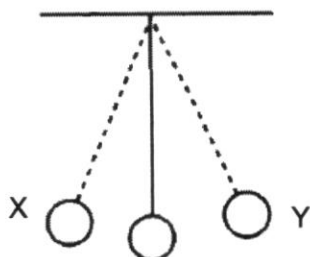


Fig. 1.1

- (a) Calculate the period.

period = ... s [1]

- (b) In another experiment, a pupil obtains the five different values for 20 oscillations of a pendulum as shown in Fig. 1.2.

time for 20 oscillations / s	12.60	12.70	12.50	12.60	12.70
-------------------------------------	-------	-------	-------	-------	-------

Fig. 1.2

Determine the period of the pendulum.

period = ... s [3]

- (c) State one way to increase the period of the pendulum.

.....
 [1]

- 2 A box of weight 400 N is at rest on a frictionless, horizontal surface. It is then being pulled to the left by a force of 200 N and it moves horizontally.

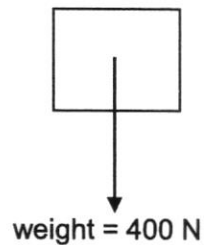


Fig. 2

- (a) Fig. 2 shows a partially completed free body diagram of the box. One of the forces has been drawn for you. Complete the diagram with arrows indicating the direction of each force. State also the magnitudes and labels of all the forces acting on the box. [2]
- (b) Calculate the mass of the box.

mass = ... kg [1]

- (c) Calculate the acceleration of the box.

acceleration = ... m/s^2 [2]

- 3 Alfred checks the purity of a small, uniform bar of gold by measuring its density. He measures the dimensions of the bar and the values are shown in Fig. 3.

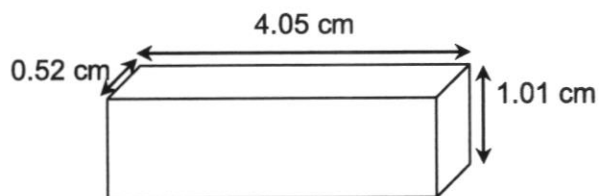


Fig. 3

- (a) Alfred has written down every digit of the readings from the measuring instrument that he used. Suggest the name of the instrument used to measure the length to the stated precision.

..... [1]

- (b) He measures the mass of the bar to be 39.0 g. Calculate the

- (i) volume of the bar,

volume = ... cm^3 [1]

- (ii) the density of the bar. Give your answer in kg/m^3 .

density = ... kg/m^3 [3]

- (c) The density of pure gold is 19300 kg/m^3 . State and explain whether the bar is made of pure gold.

.....

 [2]

- 4 (a) Fig. 4.1 shows an instrument used to measure the time that the sun shines during a day. The blackened glass bulb contains mercury and is supported inside an evacuated glass case.

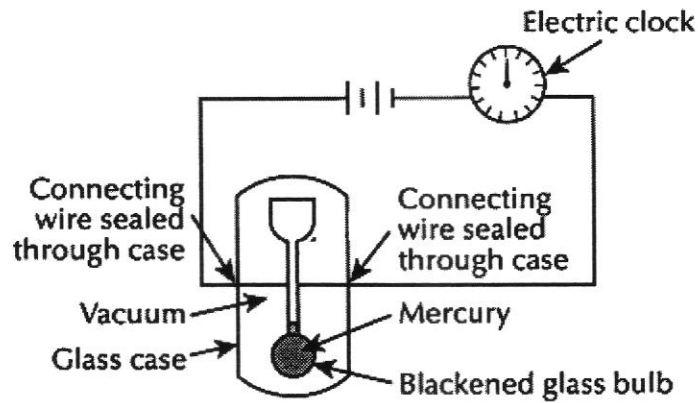


Fig. 4.1

- (i) State the mode of transfer of thermal energy from the sun to reach the mercury. Briefly explain your answer.

.....

 [2]

- (ii) State the reason why blackening the bulb ensures that the mercury level falls rapidly at night when there is no more sun.

.....
 [1]

- (b) Fig. 4.2 show a slab of ice cream that was dipped in dough mixed with bicarbonate of soda and deep fried in hot oil, also know as "fried ice-cream"

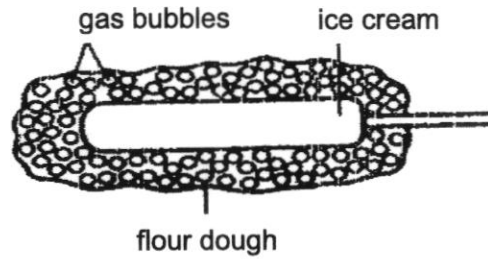


Fig. 4.2

- (i) Explain why the ice cream does not melt in the hot oil.

.....

.....

.....

..... [2]

- (ii) Describe how heat is distributed throughout the hot oil.

.....

.....

.....

..... [2]

- 5 An immersion heater is used to heat the water in a plastic cup until the water boils. The immersion heater is switched off 6.0 minutes later. Fig. 5 shows the temperature-time graph of the water.

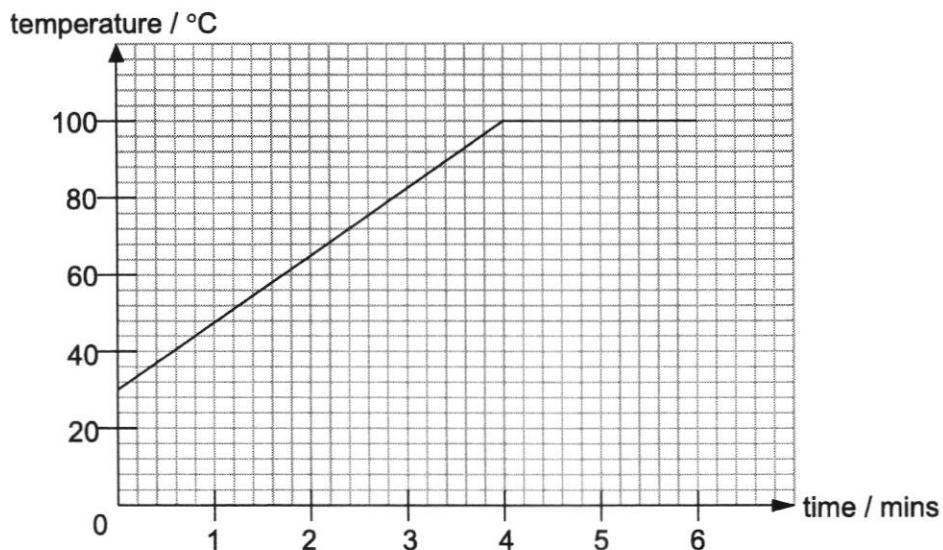


Fig. 5

- (a) State the initial temperature of the water in the cup.

initial temperature = ... °C [1]

- (b) Use the kinetic model of matter to describe what happens to the internal energy of the water during the first four minutes.

.....

 [2]

- (c) After 4.0 minutes, the temperature remains the same, even though the immersion heater is constantly supplying thermal energy.

- (i) State the process that is taking place at this constant temperature.

..... [1]

- (ii) Instead of increasing the temperature, briefly explain what happens to the thermal energy supplied by the heater.

.....

 [2]

- 6 Fig. 6.1 shows how a wave is caused to travel along a spring by moving end X while Fig. 6.2 shows the displacement-time graph of the same wave.

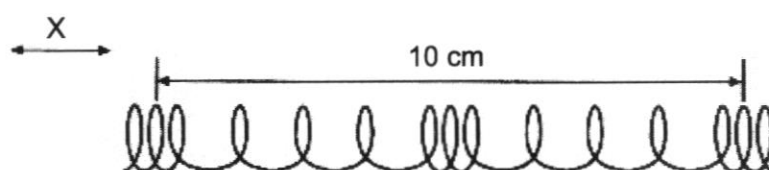


Fig. 6.1

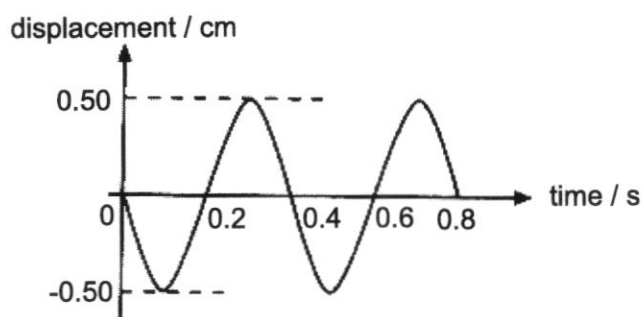


Fig. 6.2

- (a) Determine the amplitude and wavelength of this wave from Fig. 6.1 and Fig. 6.2.

amplitude = ... cm [1]

wavelength = ... cm [1]

- (b) State and explain whether this wave is transverse or longitudinal.

.....

 [2]

- (c) Calculate the

- (i) frequency,

frequency = ... Hz [1]

- (ii) and speed of this wave.

speed = ... cm/s [2]

- 7 Fig. 7 shows an object and its virtual image as viewed from a converging lens.

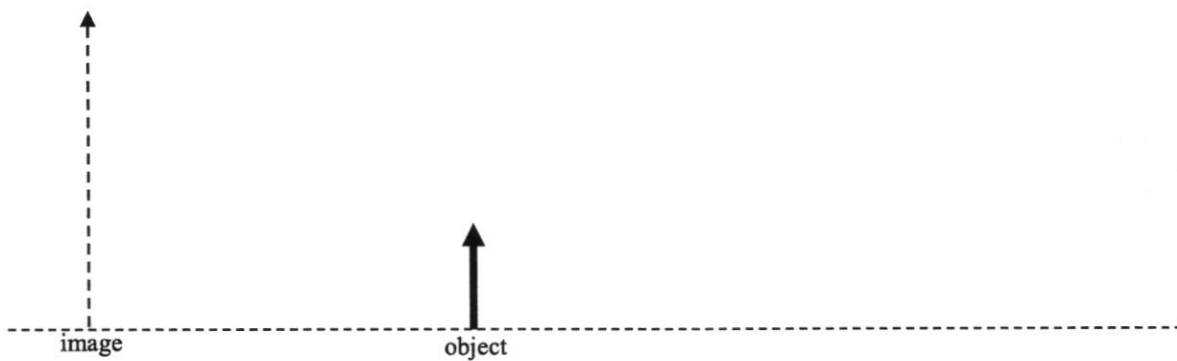


Fig. 7

- (a) Complete the ray diagram in Fig. 7 to locate the position of the lens. Draw a double-headed arrow to represent the lens and label it as L. [3]

- (b) Measure and write down the focal length of the lens used in Fig. 7.

focal length = ... cm [1]

- (c) Give two other characteristics of the image observed.

..... [1]

- 8 Fig. 8 shows a fishing boat using a sound echo to determine the depth of a shoal of fish below the boat. The echo sounder is a system, which uses high frequency sound waves.

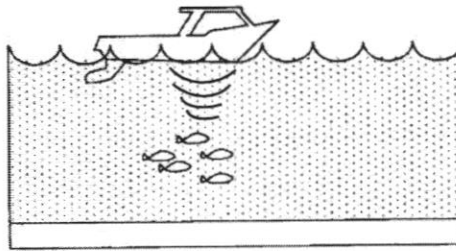


Fig. 8

- (a) If the time taken for the return of the wave is 0.067 s, calculate the depth of the shoal of fish below the boat if the speed of sound in water is 1 500 m/s.

depth of fish = ... m [2]

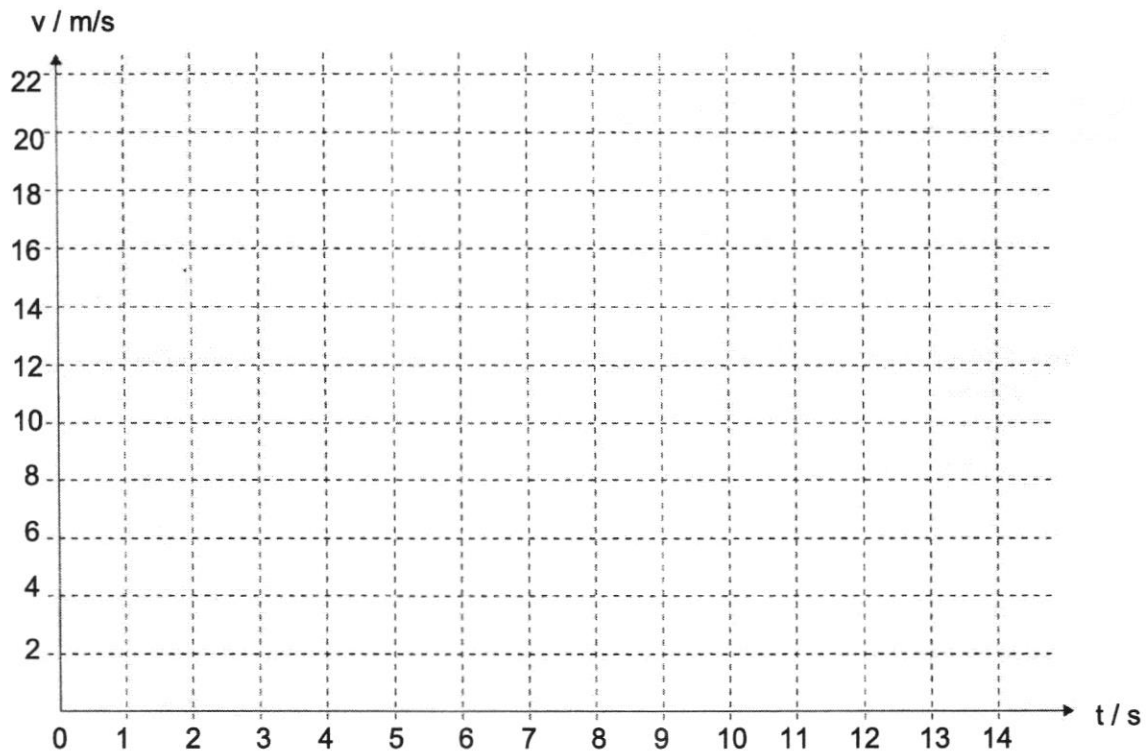
- (b) Using kinetic theory of matter, briefly explain why the speed of sound is greater in water than that in air.

.....

..... [1]

Section B (20 marks)Answer **both** questions from this section.

- 9 A car accelerates constantly from rest and reaches a speed of 12 m/s at $t = 6$ s. For the next 6 s, the car stops accelerating and moves at a constant speed.

**Fig. 9**

- (a) On Fig. 9, sketch the speed-time graph of the scenario as described. [2]
- (b) Calculate the distance travelled by the car by the 12th second.

distance = ... m [2]

- (c) A motorbike accelerates constantly from rest at the same time as the car and reaches a speed of 18 m/s at the 12th second. On Fig. 9, sketch the speed-time graph of the motorbike from 0 s to 12 s. Label this graph as B.

[1]

- (d) Calculate the acceleration of the motorbike.

acceleration = ... m/s^2 [2]

- (e) Briefly explain with the aid of calculations, if the motorbike will overtake the car at the 12th second.

.....
.....
..... [3]

- 10 Light enters an optical fibre with refractive index of 1.38 as shown in Fig.10.

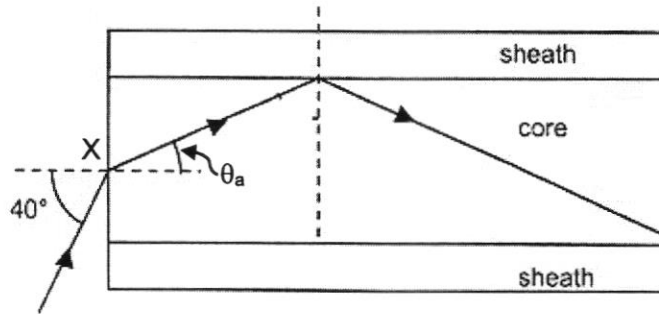


Fig. 10

- (a) Calculate the angle θ_a when the light enters the fibre at an angle of 40° to the normal.

angle $\theta_a = \dots\dots\dots^\circ$ [2]

- (b) Calculate the critical angle of the core of the optical fibre.

critical angle = $\dots\dots\dots^\circ$ [2]

- (c) Define *critical angle*.

.....

[1]

- (d) Calculate the largest possible angle (to the nearest angle) for entry at point X from air for total internal reflection to take place in the core.

largest possible angle = $\dots\dots\dots^\circ$ [2]

- (e) State and explain if the intensity of the light at the furthest end of the fibre increase or decrease when the fibre is made with a smaller refractive index.

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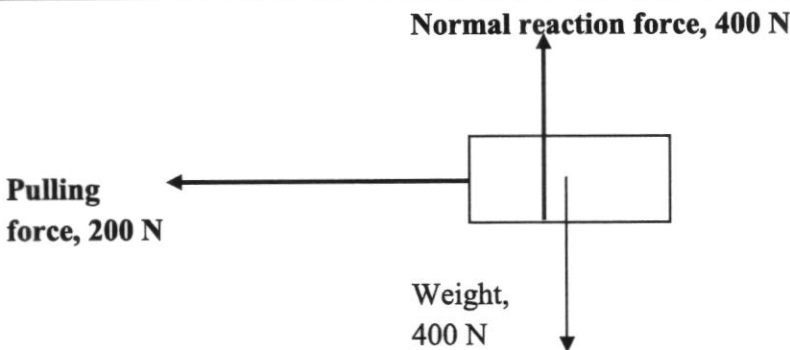
.....[3]

- End of the paper -

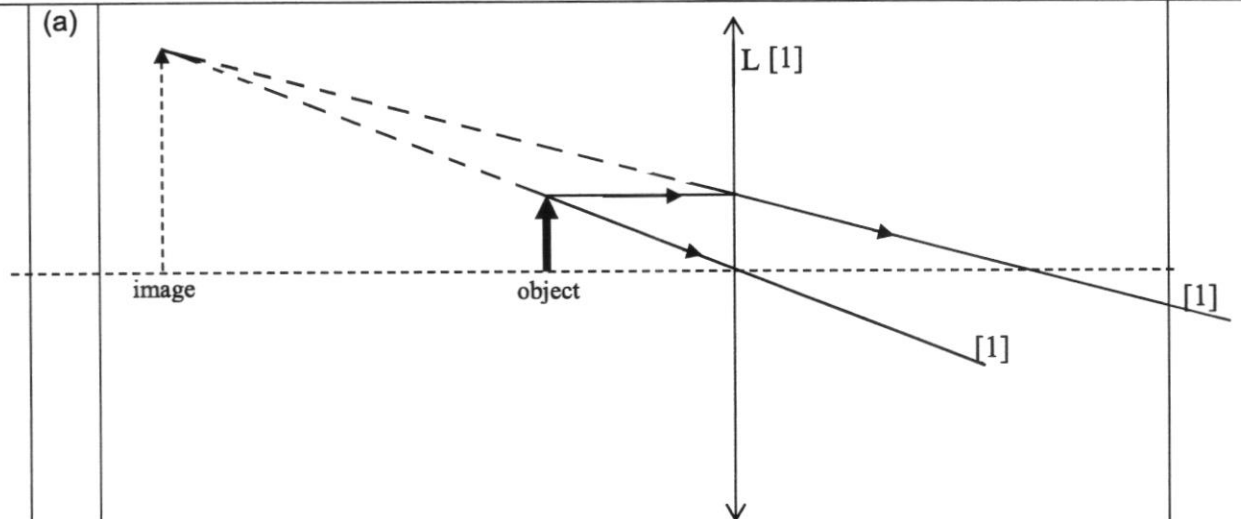
**Beatty Sec 3E Science Physics (5076) Paper 1 and Paper 2
End-Of-Year Examination 2021**

MARKING SCHEME

Paper 1 [20 marks]									
1	B	2	D	3	A	4	C	5	D
6	A	7	D	8	C	9	C	10	C
11	C	12	B	13	A	14	C	15	D
16	C	17	D	18	B	19	C	20	C

Paper 2 Section A [45 marks]			
Qn no.	Answer		Marks
	<u>-1 overall for giving answer in fractions 2 or not 3sf except for the exact figure.</u>		
1.	(a)	$1.5 \times 2 = \underline{3.0 \text{ s}}$	1
	(b)	Average = $(12.6 + 12.7 + 12.5 + 12.6 + 12.7) / 5$ = 12.62 s Period = $12.62 / 20$ = $\underline{0.631 \text{ s (3 s.f.)}}$	1 1 1
	(c)	<u>Increase the length</u> of the pendulum.	1
2.	(a)		1 mark per labelled force with magnitude
	(b)	$W = mg$ $m = w/g = 400/10 = 40 \text{ kg}$	1
		$F = ma$ $a = F/m = 200/40$ $= 5 \text{ ms}^{-2}$	1 1
3.	(a)	Vernier calipers	1
	(b)	(i) volume of the bar = $0.52 \times 4.05 \times 1.01$ = $\underline{2.13 \text{ cm}^3 \text{ (3 s.f.)}}$	1
		(ii) Density of the bar = $39.0 / 2.13$ = 18.3 g/cm^3 = $\underline{18\,300 \text{ kg/m}^3 \text{ (3 s.f.)}}$ (correct conversion)	1 1 1
	(c)	The bar is <u>not made of pure gold.</u> If the bar is pure gold, then the <u>density of the bar should be the same as gold.</u> OR The density of the bar is <u>lower than the density of pure gold.</u>	1 1

4.	(a)	(i)	Heat from the sun reaches the mercury by <u>radiation</u> . Heat can be transmitted <u>through a vacuum only by radiation in the form of infrared radiation</u> .	1 1
		(ii)	<u>Black surface is a better emitter of heat</u> , thus causing the temperature to fall rapidly.	1
	(b)	(i)	<u>Gas bubbles in the flour dough are poor conductors of thermal energy</u> , thus they <u>reduce heat transfer by conduction</u> .	1 1
		(ii)	Oil at the bottom of the frying pan is <u>heated and expands</u> . Its <u>density decreases / becomes less dense</u> . Hot oil <u>rises</u> and <u>cold, denser oil on top sinks</u> . [B1] when this movement is repeated, <u>convection currents are set up</u> . Heat in the hot oil is transferred <u>by convection</u> .	1 1
5.	(a)		30 °C	1
	(b)		<u>As the temperature increases, the water molecules moves faster</u> . Since temperature is directly related to internal kinetic energy, <u>there is an increase in the internal kinetic energy</u> . Since there is <u>no change in state</u> during the first four minutes, there is <u>very small or no change in internal potential energy</u> . Thus there is <u>an overall increase</u> in the internal energy.	1 1
	(c)	(i)	Boiling	1
		(ii)	The thermal energy supplied is used to <u>overcome / break the intermolecular bonds between water molecules</u> and also to <u>overcome the atmospheric pressure</u> as the water molecules tried to escape into the atmosphere as vapour.	1 1
6.	(a)		amplitude = <u>0.50 cm</u> wavelength = $10 \text{ cm} \div 2$ = <u>5 cm</u>	1 1
	(b)		This wave is a <u>longitudinal wave</u> as the <u>direction of vibrations is parallel to the direction of wave travel</u> .	1 1
	(c)	(i)	frequency = $\frac{1}{0.4 \text{ s}}$ = <u>2.5 Hz</u>	1
		(ii)	speed = $\frac{5 \text{ cm}}{0.4 \text{ s}}$ = <u>12.5 cm/s</u>	1 1

7.	(a)	 Note that each ray is credited only with correct solid and straight lines with arrows from object and extended with dotted lines to the image. The lens should be drawn with double-headed arrow as stated in question.	
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7	(b)	focal length of lens = 3.5 cm	1
	(c)	The image is upright and magnified .	1
8.	(a)	speed of sound = $2 \times \text{depth} / \text{time}$ $\text{depth} = (1\,500 \times 0.067) / 2$ $= 50.3 \text{ m}$	1 1
	(b)	The water molecules are closer than air molecules, hence it takes shorter time for the passing of vibrations through water and thus the speed of sound is greater in water.	1

Paper 2 Section B [20 marks]			
Qn no.	Answer		Marks
9.	(a) (c)	For (c) • 1 mark for correct graph and for labelling B For (a) with label, A: • 1 mark for correct slanted and • 1 mark for horizontal line at 12 m/s	note that the graphs "A" and "B" will be given full credit if the lines are drawn with the correct gradient and at correct value.
	(b)	$\text{Distance travelled} = \frac{1}{2} \times (6 + 12) \times 12$ $= 108 \text{ m}$	1 1
	(d)	$a = \frac{18-0}{12}$ $= 1.5 \text{ m/s}^2$	1 1
	(e)	Distance travelled by the motorbike at 12th second = area under graph B $= \frac{1}{2} \times 12 \times 18$ $= 108 \text{ m}$ The motor bike has only travelled the same distance as the car at 12th second as shown in part (b) above. The motor bike has just caught up / met up with the car at 12th second.	1 1 1
10.	(a)	$1.38 = \sin 40^\circ / \sin \theta_a$ $\theta_a = 27.8^\circ$	1 1
	(b)	$\eta = 1/\sin c$ $1.38 = 1/\sin c$ $c = 46.4^\circ$	1 1

(c)	Critical angle is <u>the angle of incidence in the optically denser medium</u> such that the <u>angle of refraction is 90° in the optically less dense medium.</u>	1
(d)	For TIR to happen, angle of refraction is at least 46.5° , thus the angle of refraction at X will be $(90 - 46.5 = 43.5^\circ)$ $\sin i / \sin 43.5 = 1.38$ $\angle i = 71.8^\circ$ largest angle = <u>72°</u> (nearest angle)	1 1
(e)	The intensity of the light will <u>decrease</u> . With a fibre of a smaller refractive index, will have a <u>larger critical angle</u> , thus <u>more rays will undergo refraction</u> at the sheath-core boundary and hence <u>the rays will travel out of the sheath along the length of the fibre by refraction</u> . Therefore, there is lower intensity of light at the furthest end of the fibre.	1 1 1