BEATTY SECONDARY SCHOOL
END OF YEAR EXAMINATION 2022
SECONDARY THREE EXPRESS

CANDIDATE NAME			
CLASS		REGISTER NUMBER	

PHYSICS

6091/01

Paper 1 Multiple Choice
Setter: Mdm Lim Yi Wen

13 October 2022
1 hour

Additional Materials:
Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, class and register number on the Multiple Choice Answer Sheet provided.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers, **A**, **B**, **C** and **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.
The use of an approved scientific calculator is expected, where appropriate.

This document consists of **14** printed pages and **0** blank pages.

[Turn over

1 Which option shows units for force in base units?

A kg m/s
B kg s/m
C kg m/s^2
D kg^2 m/s^2

2 The prefix 'milli' indicates $\times 10^{-3}$. That is, 1 millimetre is equal to 1×10^{-3} metre.

Which line in the table correctly indicates the prefixes giga, deci and nano?

	$\times 10^{9}$	$\times 10^{-2}$	$\times 10^{-9}$
A	deci	giga	nano
B	giga	deci	nano
C	giga	nano	deci
D	nano	deci	giga

3 A micrometer screw gauge is used to measure the diameter of a copper wire.

The reading with the wire in position is shown in diagram 1. The wire is removed and the gap between anvil and spindle are closed. The new reading is shown in diagram 2.

diagram 1

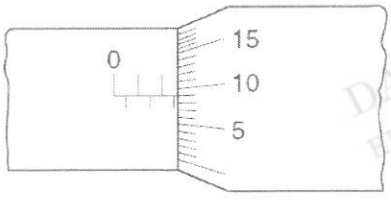
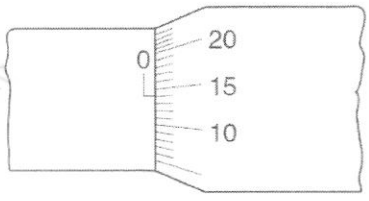


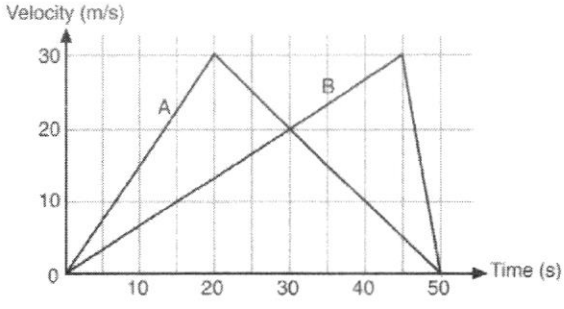
diagram 2



What is the actual diameter of the copper wire?

A 1.95 mm **B** 2.09 mm **C** 2.45 mm **D** 2.59 mm

4 The velocity-time graph for two cars A and B in a race are shown below.



What is the distance between the two cars at the time when they have the same velocity?

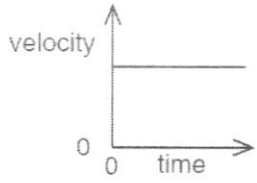
A 250 m **B** 300 m **C** 600 m **D** 750 m

5 A particle is moving in a straight line with uniform acceleration.

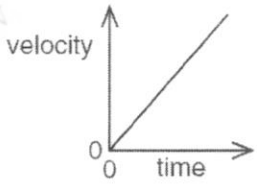
Which graph represents the motion of the particle?

A

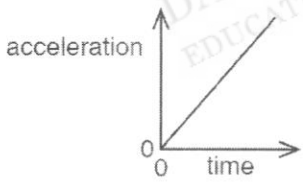
B



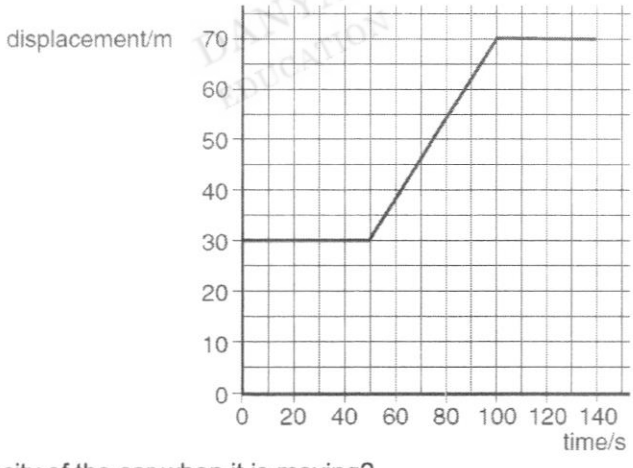
C



D



6 A stationary car in a traffic queue moves forward in a straight line and then comes to rest again. The graph shows the variation with time of its displacement.



What is the velocity of the car when it is moving?

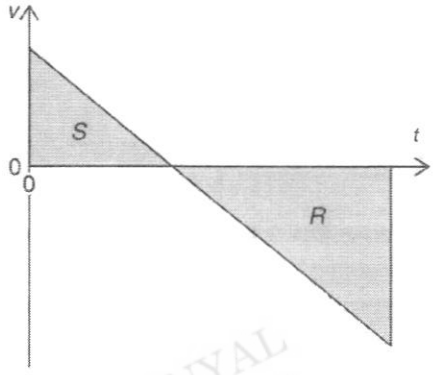
A 0.29 m/s **B** 0.50 m/s **C** 0.80 m/s **D** 2.0 m/s

7 A large metal ball and a small sponge ball are dropped from the top of a high building. They are released at the same time. The metal ball reaches the ground first.

Which statement explains this?

A Heavier objects accelerate faster than lighter objects in Earth's gravitational field.
B The acceleration due to free fall depends on mass of an object.
C The metal ball reaches the ground at a high speed before attaining the air resistance that is equal to its weight.
D There is smaller air resistance on lighter object.

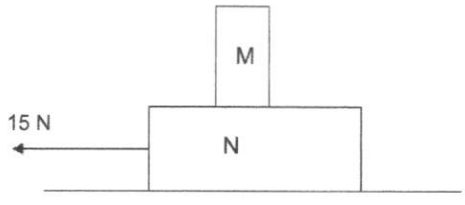
8 A stone is thrown upwards from the top of a cliff. After reaching its maximum height, it falls past the cliff-top and into the sea. The graph shows how the vertical velocity v of the stone varies with time t after being thrown upwards. R and S are the magnitudes of the areas of the two triangles.



What is the height of the cliff-top above the sea?

A R **B** S **C** R-S **D** R+S

9 Two objects, M (mass = 1 kg) and N (mass = 2 kg) are stacked one on top of another as shown below. If all the surfaces are regarded as frictionless, what would be the acceleration of object N when it is pulled by a force of 15 N?



A 5.0 m/s^2 **B** 7.5 m/s^2 **C** 10.0 m/s^2 **D** 15.0 m/s^2

10 A moving car of mass 800 kg accelerates at 1.0 m/s^2 when the force due to the engine is 1000 N. What is the average frictional force on the car?

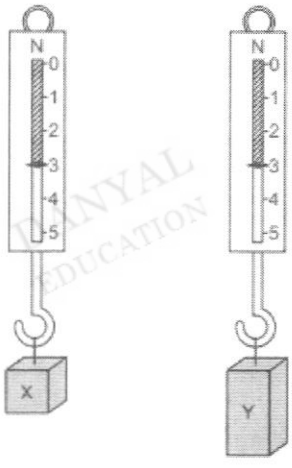
A 200 N **B** 800 N **C** 1000 N **D** 1800 N

11 A child sits on a rubber ball and bounces up and down on the ground.

What stays the same when the ball hits the ground?

A the acceleration of the ball
B the mass of the ball
C the shape of the ball
D the velocity of the ball

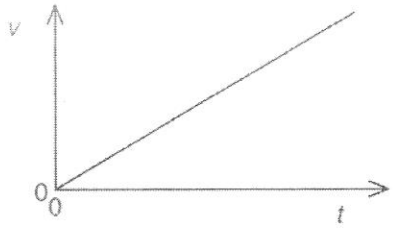
12 Two blocks of metal X and Y hang from spring balances, as shown in the diagrams.



What does the diagram show about X and Y?

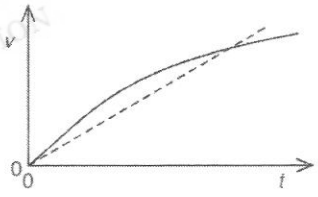
A They have the same mass and the same volume but different weights.
B They have the same mass and the same weight but different volumes.
C They have the same mass, the same volume and the same weight.
D They have the same weight and the same volume but different masses.

13 A body falls from rest in a vacuum near the Earth's surface. The variation with time t of its speed v is shown below.

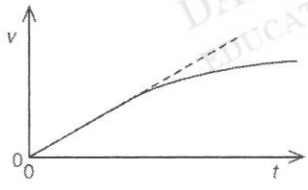


Which graph shows the variation with time t of the speed v of the same ball falling in air at the same place on Earth?

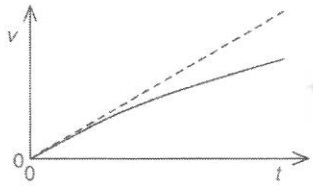
A



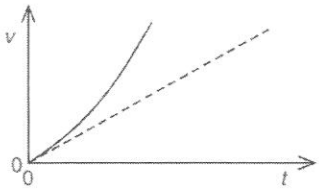
B



C



D



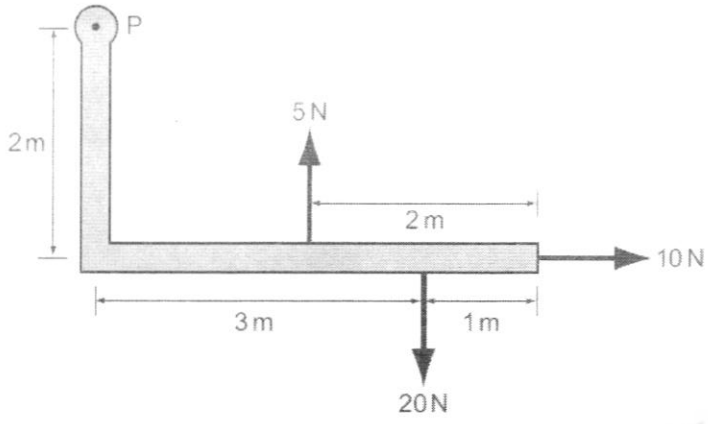
14 What is the centre of gravity of an object?

A the geometrical centre of the object
B the point about which the total torque is zero
C the point at which the weight of the object may be considered to act
D the point through which gravity acts

15 Which object has the greatest inertia?

A a 20-cent coin (2.4 g)
B a glass marble (6.5 g)
C an A4 size corrugated board (15.6 g)
D a wooden metre rule (75.6 g)

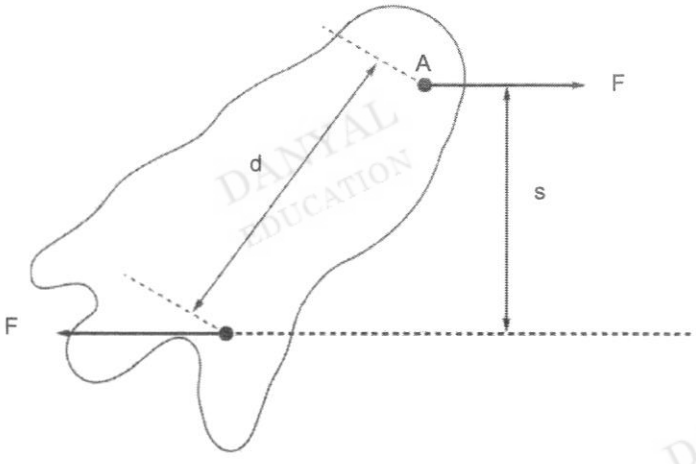
16 An L-shaped rigid lever arm is pivoted at point P.



What is the overall moment acting on the L-shaped lever arm?

A 30 Nm **B** 40 Nm **C** 50 Nm **D** 90 Nm

17 A lamina is suspended freely from point A.

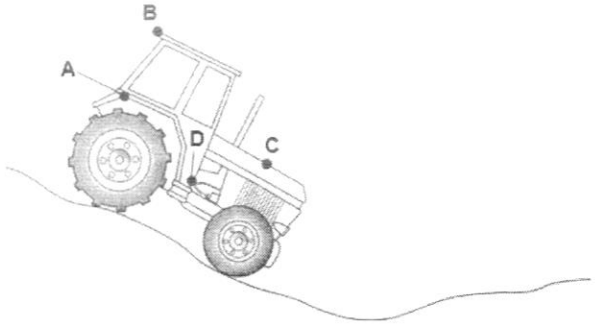


The lamina is displaced to the position shown.

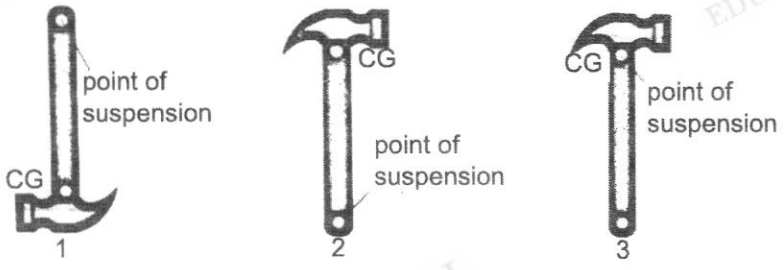
What is the moment due to force F about A?

A Fd **B** Fs **C** $2Fs$ **D** $F\sqrt{(d^2 - s^2)}$

18 A tractor is being used on rough ground. Where should the centre of gravity of the tractor be located so that the tractor is **least** likely to topple?



19 A hammer can be suspended in equilibrium from three different positions as shown.



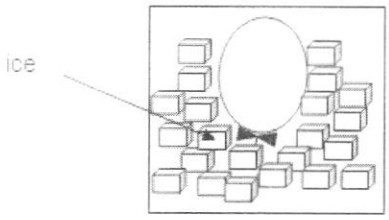
Which of the following matches the figure with their types of equilibrium?

	neutral	stable	unstable
A	3	1	2
B	1	2	3
C	2	1	3
D	3	2	1

20 Which row in the table gives approximate ratios of density and molecular spacing for a substance in its solid, liquid and gas phases?

	density			molecular spacing		
	solid	liquid	gas	solid	liquid	gas
A	1000	1000	1	1	1	1
B	1000	1000	1	1	1	1000
C	1000	100	1	1	100	100
D	1000	100	1	1	1000	1000

21 The gas in a sealed balloon is cooled down. No gas enters or leaves the balloon.



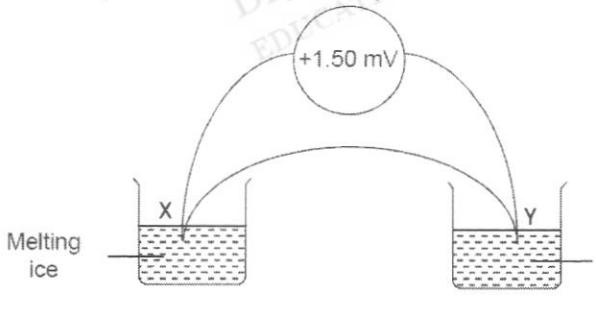
How do the listed properties of the gas change?

	mass	volume	density
A	decreases	stays the same	increases
B	increases	stays the same	decreases
C	stays the same	decreases	increases
D	stays the same	increases	decreases

22 A metal ring is heated by a strong fire for 5 minutes. What happens to its inner and outer diameter of the ring?

	inner diameter	outer diameter
A	decreases	increases
B	decreases	decreases
C	increases	increases
D	increases	decreases

23 The diagram shows a thermocouple thermometer when junctions X and Y are placed in melting ice and in a liquid at 30 °C respectively.



What is the voltmeter reading when junction X is removed and placed in boiling water instead?

A - 5.00 mV **B** - 3.50 mV **C** + 3.50 mV **D** + 5.00 mV

24 Which of the following best explains steam point?

A The temperature of pure water when it boils at a standard atmospheric pressure.
B The temperature of pure water just after it boils at standard atmospheric pressure.
C The temperature of steam from pure boiling water at standard atmospheric pressure.
D The temperature of the air above pure boiling water at standard atmospheric pressure.

25 A certain liquid is used in a liquid-in-glass thermometer. It does not expand uniformly with temperature.

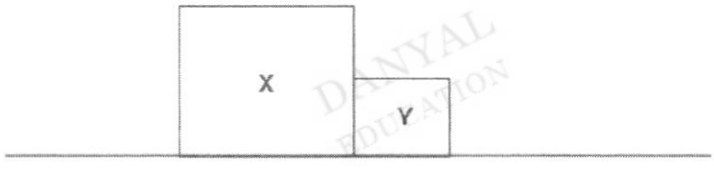
What effect will this have on the scale of the thermometer?

A It will have a small range.
B It will be non-linear.
C The markings will be close together.
D The markings will be far apart.

26 A glass jug is designed so that it does not break when boiling water is poured into it. What sort of glass should be used?

	Thickness	Expansion
A	thick	expand greatly when heated
B	thick	expand little when heated
C	thin	expand greatly when heated
D	thin	expand little when heated

27 Two copper blocks X and Y are placed in a container of boiling water at the same time for 5 minutes, removed and placed in contact with each other on the laboratory bench as shown. The room temperature remains at 27 °C.



Which statement about the copper blocks is correct when X and Y are initially placed in contact?

A Energy is transferred from X to Y.
B X has more energy than Y.
C X is at a higher temperature than Y.
D X will cool down faster than Y.

28 When energy is removed from an unknown substance, the average separation of the molecules decreases drastically.

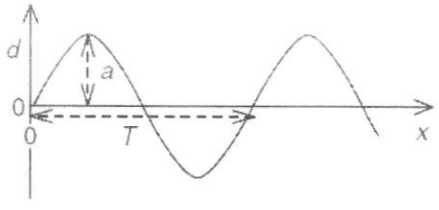
What is the type of energy involved?

A internal kinetic energy
B latent heat of fusion
C latent heat of vaporisation
D specific heat capacity

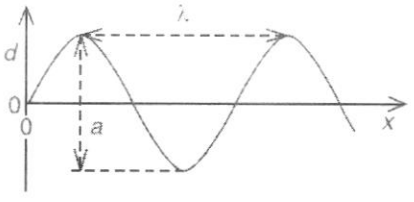
29 In the graphs below, x is distance; d is displacement; a is amplitude; T is period; λ is wavelength; t is time.

Which graph is correctly labelled?

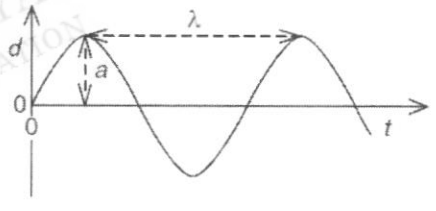
A



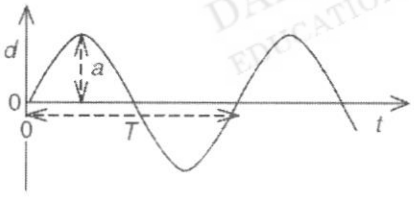
B



C

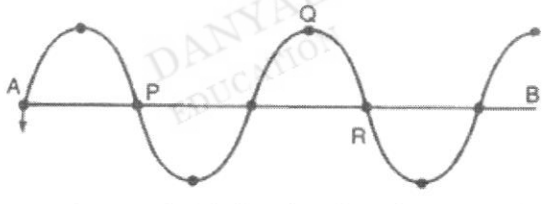


D



30 In the diagram below, a rope wave is moving from A to B.

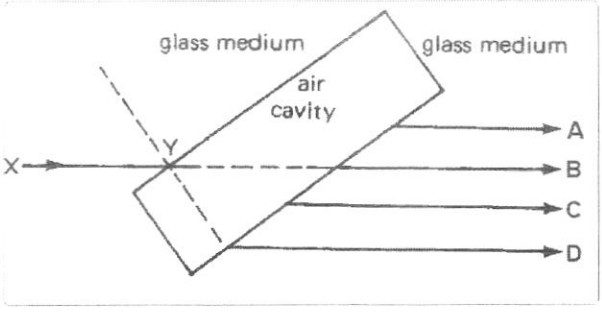
P, Q and R are points on the wave.



At the particular instance shown, what is the direction of movement of points P, Q and R?

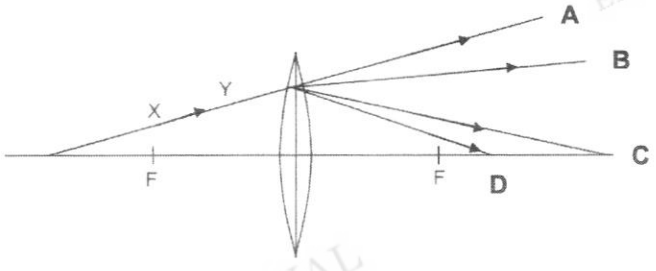
	P	Q	R
A	down	down	down
B	down	up	up
C	up	down	up
D	up	up	up

31 A ray of light XY incident on a rectangular air cavity.



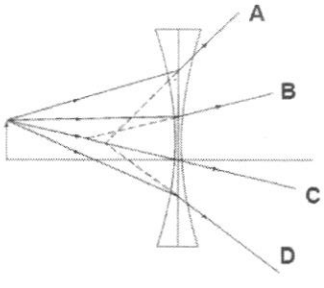
Which ray **A**, **B**, **C** or **D** is most likely to represent the path of the light ray in the glass after emerging from the air cavity?

32 Which will be the most probable path of the ray XY after passing through the lens?



33 In the diagram below, only three light rays from the object passing through the diverging lens are correctly drawn.

Which light ray **A**, **B**, **C** or **D** is **incorrectly** drawn?



34 Which value is a possible wavelength for radiation in the microwave region of the electromagnetic spectrum?

A 3×10^{-2} m **B** 3×10^{-5} m **C** 3×10^{-8} m **D** 3×10^{-10} m

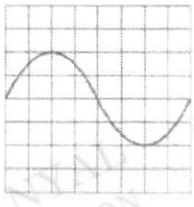
35 Which row correctly describes the frequency and speed of the wave when going from infra-red radiation to ultraviolet radiation in the electromagnetic spectrum?

	frequency	speed in vacuum
A	decrease	increase
B	increase	decrease
C	increase	remains the same
D	remains the same	increase

36 Which is **not** a property of X-rays?

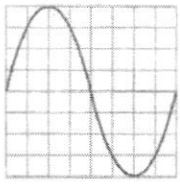
A It can travel through vacuum.
B It has higher frequencies than gamma rays.
C It is a transverse wave.
D It travels at the speed of light in vacuum.

37 The diagram shows the waveform of a musical note on a cathode ray oscilloscope screen where the horizontal axis is time.

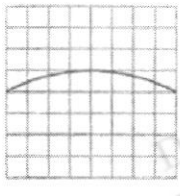


Which diagram shows a waveform of a louder and higher pitched musical note?

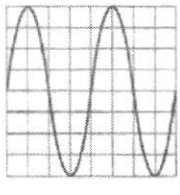
A



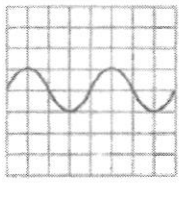
B



C



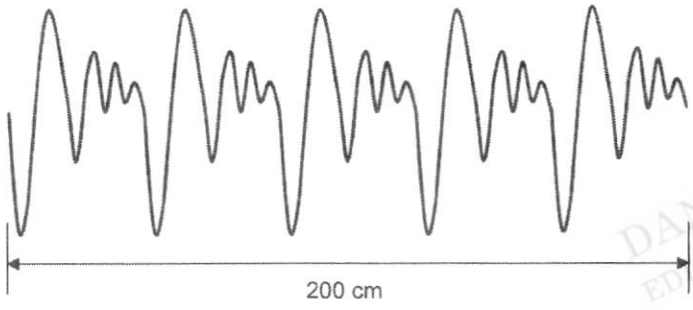
D



38 Which factor will affect the frequency of a sound wave?

A the loudness of the sound wave
B the medium in which the sound wave travels in
C the source of the sound wave
D the speed of the sound wave

39 The waveform of a violin's musical note is shown in the figure below.



Given that the speed of sound in air is 340 ms^{-1}, what is the frequency of the musical note?

A 1.7 Hz B 50 Hz C 136 Hz D 850 Hz

40 A boy stands in front of a cliff. He claps his hands so that every clap coincides with the echo of his previous clap. He discovers that he claps his hands every 1.2 s. The velocity of sound in air is 340 ms^{-1}.

What is the distance between the cliff and the boy?

A 204 m B 283 m C 408 m D 567 m

BEATTY SECONDARY SCHOOL
END OF YEAR EXAMINATION 2022
SECONDARY THREE EXPRESS

CANDIDATE NAME			
CLASS		REGISTER NUMBER	

PHYSICS

6091/02

Paper 2 Theory
Setter: Mdm Lim Yi Wen

05 October 2022
1 hour 45 minutes

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Section A
Answer **all** questions.

Section B
Answer **all** questions. Question 12 has a choice of parts to answer.

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.

The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
A	50
B.....	9
B.....	12
B.....	9
Total	80

This document consists of **18** printed pages and **0** blank pages.

[Turn over

Section A

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

1 Fig. 1.1 shows some masses on a mass hanger attached to an elastic band. The elastic band is stretched by the masses.

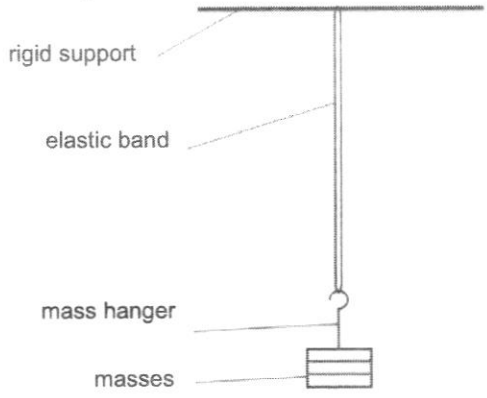


Fig. 1.1

A student pulls the mass hanger down slightly and then releases it. The mass hanger and masses oscillate up and down.

The student uses a stop-watch to time 20 oscillations. Fig. 1.2 shows the time reading on the stop-watch after the 20th oscillation.

Fig. 1.2

(a) Calculate the period of the oscillation.

period = ... [1]

(b) A student is asked to draw the free body diagram of the masses on the mass hanger attached to an elastic band.

Fig. 1.3 shows the diagram drawn by the student.

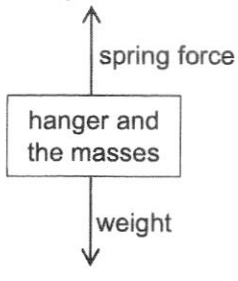


Fig. 1.3

The teacher states that Fig 1.3 does not show an action-reaction pair of forces.

State **two** reasons why these two forces are **not** an action-reaction pair.

.....

..... [2]

2 A ball rolls down a ramp and onto a horizontal surface. The first section of the horizontal surface is smooth. The second section of the horizontal surface is rough. Fig. 2.1 shows a speed–time graph for the ball.

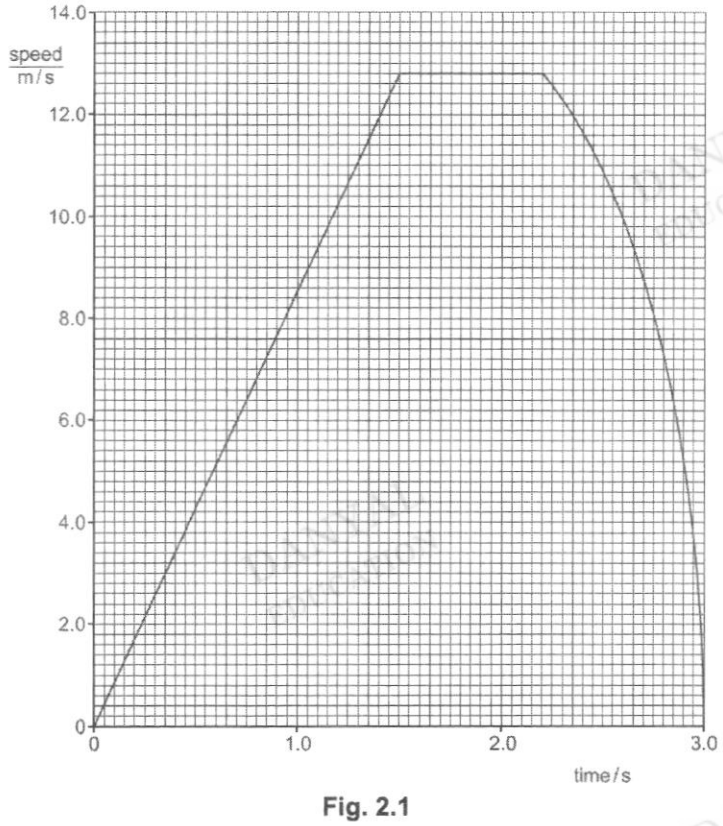


Fig. 2.1

(a) Describe the motion of the ball.

.....

.....

..... [2]

(b) With reference to Fig. 2.1, explain how the motion of the ball obey Newton's first law.

.....

.....

..... [2]

(c) The ball starts from rest at the top of the ramp at constant acceleration.

Show that the length of the ramp is 9.6 m.

[2]

3 A student is doing some physical exercise. Fig. 3.1 shows the student holding a 50 N weight.

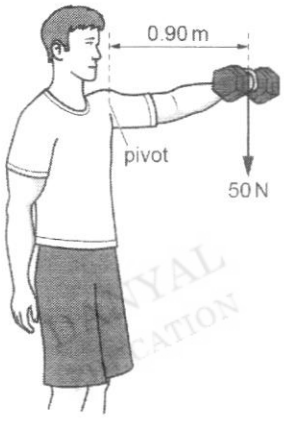


Fig. 3.1

The shoulder, which functions as the pivot in this exercise, is 0.90 m from the centre of mass of the weight.

(a) Calculate the moment of the weight about this pivot in the shoulder.

moment = ... [2]

(b) Explain why the clockwise moment about the shoulder is more than the moment calculated in **(a)**.

.....

.....

..... [1]

4 Fig. 4.1 shows a sealed glass syringe that contains air and many small, suspended dust particles.

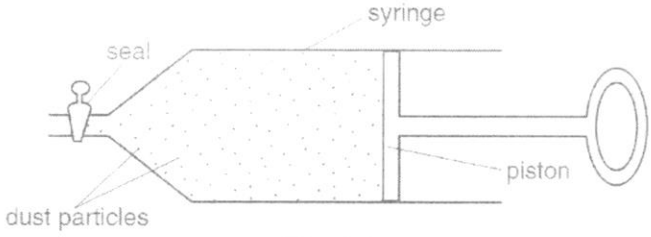


Fig. 4.1

(a) Explain why the dust particles are suspended in the air and **do not** settle to the bottom.

.....

.....

..... [2]

(b) State and explain the movement of dust particles if the syringe is heated.

.....

.....

..... [2]

(c) The pressure of the air in the syringe is at a pressure of 2.0×10^5 Pa. The piston is pushed slowly into the syringe, keeping the temperature constant, until the volume of the air is reduced from 80 cm^3 to 20 cm^3.

(i) Explain why the piston has to be pushed slowly into the syringe.

.....

..... [1]

(ii) Calculate the final pressure of the air.

pressure of the air = ... [2]

5 In some countries, the soil is too cold for plants to grow well. In these countries, plants are kept indoors and are grown in plastic pots containing soil that are placed on sand. The sand is heated by an electrical heater, as shown in Fig. 5.1.

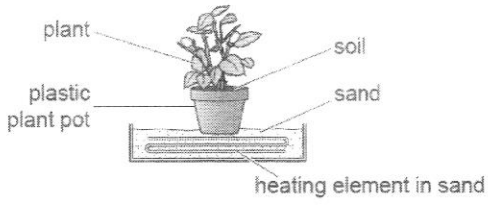


Fig. 5.1

(a) Describe, in terms of particles, how thermal energy from the heated sand is transferred through the base of the plastic pot.

.....

.....

..... [2]

(b) The heating element in Fig. 5.1 remains switched on. The temperature of the sand remains constant at a value above room temperature.

Suggest why the temperature of the sand remains constant.

.....

..... [2]

6 A mercury-in-glass thermometer is placed in an insulated beaker containing 100 g of water at 60 °C. The water is heated at a constant rate. The temperature of the water is measured and recorded on the graph shown in Fig. 6.1.

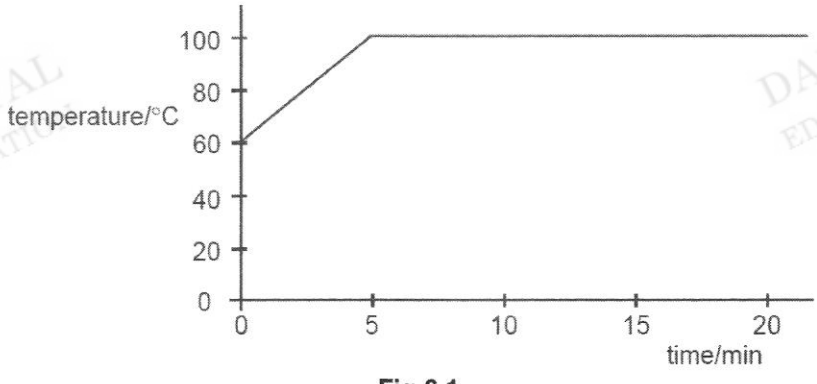


Fig 6.1

(a) State the earliest time when boiling is observed.

time = ... [1]

(b) If the beaker now contains 200 g of water, sketch the temperature-time graph on Fig. 6.1. [2]

(c) Some water evaporates as the temperature of water rises. Explain in terms of molecular behaviour, why energy is needed for evaporation.

.....

.....

..... [2]

7 A jeweller wishes to harden a sample of pure gold by mixing gold with silver to obtain a mixture is which silver makes up 5% of its total mass. The jeweller melts some pure gold and heated the liquid gold to temperature θ. He then adds the liquid gold to solid silver. The initial temperature of silver is at 30 °C. The total mass of the mixture is 1.5 kg.

Table 7.1 shows some information regarding gold and silver

Table 7.1

	gold	silver
melting point / °C	1067	967
specific heat capacity / J kg^{-1} $°C^{-1}$ (solid or liquid)	129	235
specific latent heat of fusion / kJ kg^{-1}	628	105

(a) Explain what is meant by the *specific heat capacity of gold is 129 J kg^{-1} $°C^{-1}$.*

.....

..... [1]

(b) Calculate the thermal energy required to melt the required mass of silver.

thermal energy required to melt silver = ... [2]

(c) Calculate the thermal energy required to raise the temperature of silver to the melting point of gold.

thermal energy required to heat silver = ... [2]

(d) Calculate temperature θ.

θ = ... [2]

8 Fig. 8.1 shows a cross-section through a swimming pool.

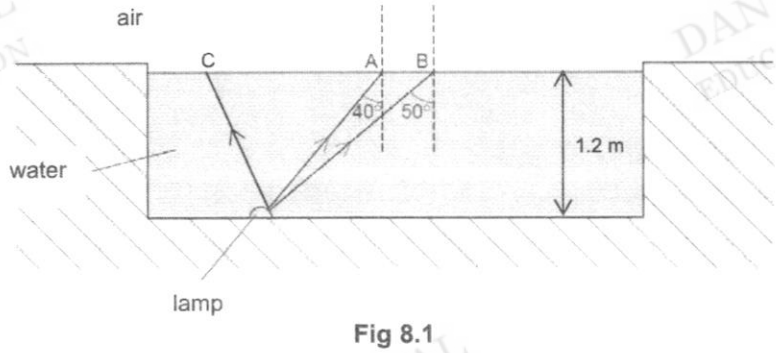


Fig 8.1

A ray of monochromatic light (light of a single colour) from a lamp at the bottom of the pool strikes the surface at A, as shown in Fig. 8.1.

The water in the swimming pool has a refractive index of 1.33.

(a) Calculate the angle of refraction at A.

angle of refraction at A = ... [2]

(b) Calculate the critical angle of water.

critical angle, c = ... [2]

(c) Another ray of light strikes the surface at B as shown in Fig. 8.1. State and explain what happens to the ray of light at B.

.....

.....

.....

.....

..... [3]

(d) Light rays also emerge from C. Together, these rays of light form a circular spot when viewed from the top.

Calculate the radius of the circular spot.

radius of spot = ... [3]

9 A battle re-enactment enables observers to see and hear an old cannon being fired.

Fig. 9.1 shows the battle site and the distant cliffs.

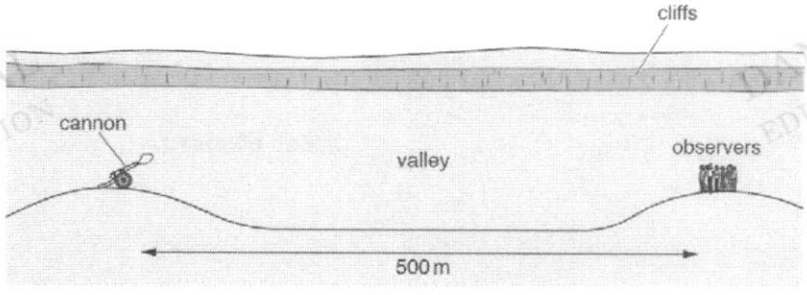


Fig 9.1

The cannon is fired. Observers see the smoke and then hear the bang.

(a) Explain why there is a short delay between seeing the smoke and hearing the bang of the cannon.

.....

..... [1]

(b) One of the observers placed his ears on the ground and heard 2 separate bangs of the cannon. The first bang was softer than the second bang.

Explain why there are two separate bangs of the cannon and their difference in their loudness.

.....

.....

..... [2]

(c) Another observer is standing 500 m away from the cannon. He uses a stopwatch to measure the time delay between seeing the smoke and hearing the first bang. His timings are shown in Table 9.2.

Table 9.2

measurement	time delay / s
1	1.9
2	1.5
3	1.3
4	1.4
5	1.7

Use the measurements in Table 9.2, calculate an accurate value for the speed of the sound produced by the cannon.

speed of sound = ... [2]

Section B

Answer **all** the questions in this section.
Answer only one of the two alternative questions in **Question 12**.

10 A bimetallic strip is made from two materials, brass and iron, joined together. A student clamps the bimetallic strip, as shown in Fig. 10.1, and heats the end.

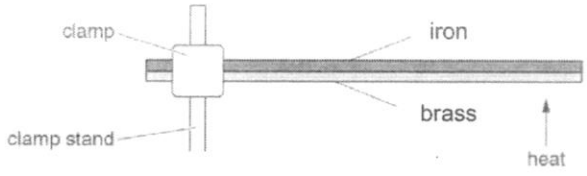


Fig. 10.1

When the bimetallic strip is heated, brass expands more than iron. The bimetallic strip bends.

(a) Explain, in detail, why metals expand when heated.

.....

.....

.....

..... [2]

(b) On Fig. 10.1, sketch the position of the strip after it has been heated. [1]

(c) Using fixed points, suggest how the bimetallic strip may be used to measure temperature.

.....

.....

.....

.....

..... [3]

(d) Suggest a reason why, in practice, a thermometer using this bimetallic strip would be difficult to use.

.....

..... [1]

(e) The bimetallic strip was placed in a heating tank of water that is kept at 60 °C. A resistance thermometer was used to check if the temperature of the water was indeed at 60 °C.

The resistance of the resistance thermometer at 0 °C is 3840 Ω. At 100 °C, the resistance of the resistance thermometer is 190 Ω.
Calculate the resistance of the resistance thermometer when the temperature is at 60 °C.

resistance = ... [2]

11 Fighter planes are only able to fly because of the lift generated from high-speed air flowing across the wings. If a plane does not accelerate enough, it will not take off from the ground.

An average fighter plane takes off after it reaches a speed of 69.0 m/s. For a fighter plane of mass 24 000 kg, it undergoes constant acceleration and takes 6.0 s to lift off the ground.

(a) Calculate the initial acceleration of the fighter planes.

acceleration of the planes = ... [2]

(b) Calculate the forward force produced by the engine thrust of the fighter plane.

forward force = ... [2]

(c) Calculate the weight of the fighter plane.

weight = ... [2]

(d) In order to fly, there is a upward lift force produced at the wings due to Bernoulli's Principle. Assuming the vertical lift force is equal in magnitude to its weight. Using a scaled vector diagram (not calculation) of the lift force of the fighter plane and the forward force produced by the engine thrust, determine the resultant force acting on the fighter plane.

angle of inclination from the horizontal = ...

magnitude of resultant force = ... [3]

(e) On ground, the length of a typical runway is 210 m.

Sometimes, a fighter plane may have to take off on a aircraft carrier. An aircraft carrier has a runway for these planes to take off. Though these carriers may be large, they cannot be as long as land runway. A typical runway on an aircraft carrier is about 86 m long. Fig. 11.1 shows an aircraft carrier with a runway.

Fig. 11.1

To overcome this, an aircraft catapult is used to allow aircraft to take off from a very limited amount of space.

Fig 11.2 shows a diagram of the aircraft catapult.

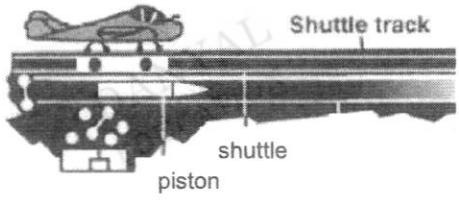


Fig. 11.2

When the steam powered piston of the catapult moves to the right, it brings the plane along with it, hence launching the plane.

Calculate the acceleration that is required for the fighter plane to take off within the runway of length 86 m on an aircraft carrier.

acceleration = ... [3]

12 EITHER

A student is having a medical examination.

A dentist checks the student's teeth using a dental mirror made of a plane mirror as shown in Fig. 12.1.

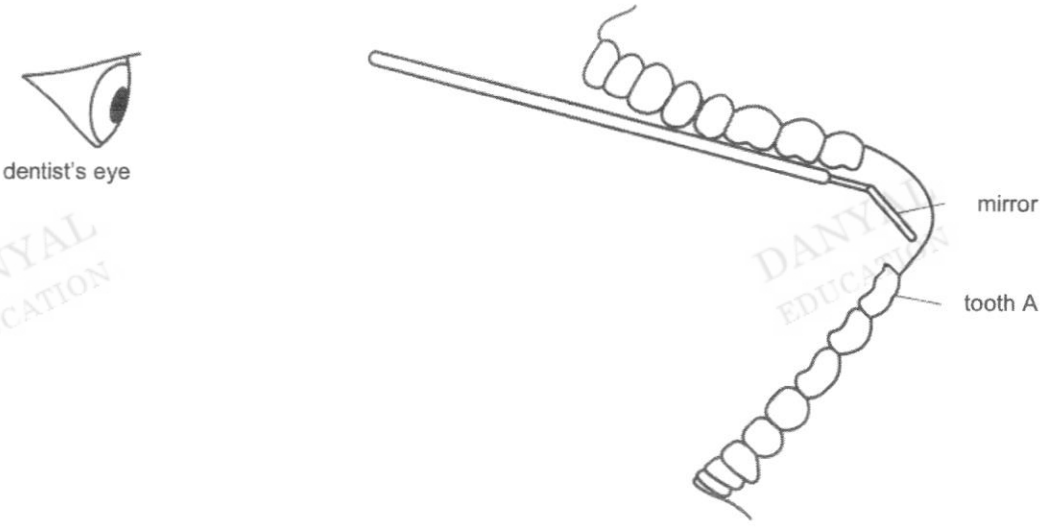


Fig. 12.1

(a) Draw two rays of light from the back of tooth A to the dentist's eye to show how the dentist is able to see the back of the tooth. [3]

(b) Suggest one modification to the dental mirror so as to allow the dentist to see a bigger image of the back of the tooth.

.....

..... [1]

(c) After the examination, the student went for a dental X-ray.

Dental X-rays or radiographs are images of your teeth that your dentist uses to evaluate your oral health. X-rays can help your dentist to identify problems, like cavities, tooth decay, and impacted teeth.

(i) Explain why X-rays are used in dental imaging.

.....

..... [1]

(ii) While taking X-rays, a lead "bib" has to be worn to cover the student's chest, abdomen, and pelvic region to prevent any unnecessary radiation exposure to his vital organs.

Explain why the lead "bib" has to be worn by the student while taking the X-ray.

.....

.....

..... [2]

(iii) The frequency of dental X-ray is 7.0×10^{18} Hz.

Calculate the wavelength of dental X-ray.

wavelength = ... [2]

12 OR

Table 12.2 lists some facts about the first seven planets which orbit the Sun. The orbits of the planets may be taken as circles with the Sun at the centre of each circle. The orbital radius is the distance from the planet to the Sun. The orbital period is the time taken for the planet to orbit once around the Sun. The rotation period is the time taken for a planet to rotate once about its own axis.

Table 12.2

	radius of planet/ 10^6 m	mass of planet/ 10^{25} kg	rotation period/ 10^6 s	orbital Radius/ 10^{10} m	orbital period/ 10^7 s	surface temperature/ °C
Earth	6.38	0.597	0.086	15.0	3.16	15
Jupiter	71.5	190	0.036	77.8	37.4	-150
Mars	3.40	0.064	0.089	22.8	5.93	-23
Mercury	2.44	0.033	5.07	5.79	0.76	90
Saturn	60.3	56.8	0.038	142	93.0	-180
Uranus	25.5	8.68	0.062	287	265	-214
Venus	6.05	0.489	20.9	10.8	1.94	480

Circumference of circle = $2\pi r$

(a) Given that Earth revolves around the Sun in a circular orbit, calculate the orbital speed of Earth orbiting around the Sun.

orbital speed of Earth = ... [2]

(b) The distance between the planets change as they orbit the Sun. Determine the greatest distance between any **two** of the planets in the table.

distance = ... [1]

(c) A substance has a melting point of – 185 °C and a boiling point of 10 °C.

State the planet(s) on which the substance will be a liquid.

.....

..... [1]

(d) The gravitational field strength, g is given by

$$g = \frac{GM}{r^2}$$

where G is the gravitational constant; M is the mass of planet and r is the radius of planet.

G = $6.67 \times 10^{-11} Nm^2 kg^{-2}$

(i) Explain what is *gravitational field strength*.

.....

..... [1]

(ii) Calculate gravitational field strength, g of the heaviest planet.

gravitational field strength, g = ... [1]

(iii) An astronaut of mass 60 kg visited the heaviest planet in **(d)(ii)**.

Compare and explain the difference (if any) in the mass and weight of the astronaut on Earth and on the heaviest planet.

.....

.....

.....

..... [3]

BEATTY SECONDARY SCHOOL
END OF YEAR EXAMINATION 2022
SECONDARY THREE EXPRESS

CANDIDATE NAME **ANSWER**

CLASS

REGISTER NUM

PHYSICS		**6091/02**
Paper 2	Theory	05 October 2022
Setter:	Mdm Lim Yi Wen	1 hour 45 minutes

Candidates answer on the Question paper
No Additional Materials are required.

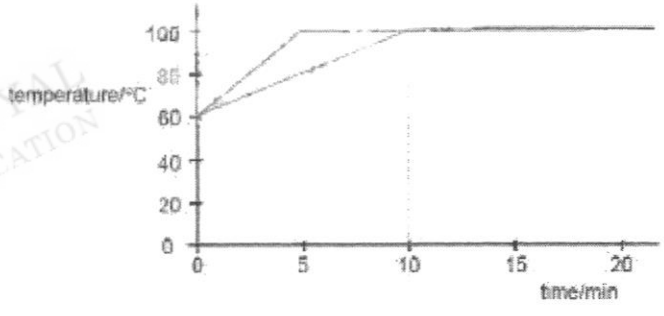
Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
C	B	C	A	C	C	C	C	A	A

Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20
B	B	C	C	D	A	B	D	A	B

Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30
C	C	B	C	B	D	B	C	D	C

Q31	Q32	Q33	Q34	Q35	Q36	Q37	Q38	Q39	Q40
A	C	B	A	C	B	C	C	D	A

Qn	Answers	Marks	Remarks
1a	Total time = 1 min 6.40 s =66.4s Period = 66.4 / 20 =3.32s	1	
1b	The two forces do not belong to the same type. They are not on mutually opposite bodies.	2	
2a	Object is moving at constant acceleration at 8.53 m/s^2 for 1.5s till it reached a constant speed of 12.8 m/s. Then it undergoes increasing deceleration at 2.2s. 1m for general trend, 1m for numerical reference	2	
2b	Ball is moving at constant speed / no acceleration between t = 1.5 s. to t = 2.25 s as there is no net force acting on the ball.	1 1	
2c	Object is moving down the ramp at constant acceleration.	1	

	Length of ramp is the distance travelled is the area under the graph of constant acceleration Area under the graph = ½ × 12.8 × 1.5 = 9.6m	1	
3a	Moment = F X ⊥ d = 50 X 0.90 = 45 Nm	1 1	
3b	The clockwise moment in (a) did not include the clockwise moment due to the weight of the hand.	1	
4a	Air molecules are in constant and random motion. The random, constant and uneven bombardment of the air molecules with the dust particles caused the dust particles to be moving. Thus, making it difficult for the dust to settle.	1 1	
4b	When heated, air particles have an increased kinetic energy which resulted in moving faster and hitting the dust particles more frequently with greater force. The dust particles will be moving more vigorously and faster.	1 1	
4ci	Any sudden moment of the piston may cause the air molecules to move faster.	1	
4cii	At 80 cm^3, p = 2.0×10^5Pa $p_1V_1 = p_2V_2$ 2.0×10^5Pa X 80 = p X 20 p = 8.0×10^5Pa	1 1	
5a	The particles of the plastic pot that is heated from the sand will gain kinetic energy and vibrate faster. these particles collide with the less energetic neighbours Some of the energy is transferred to these neighbouring particles, which in trun gain kinetic ergy and vibrate faster Hence, the pot is heated	1 1	
5b	Heat is lost to the environment as it at a higher temperature Heat produced by the heater is equal to the rate of heal loss to the environment	1 1	
6a	Time = 5 min	1	
6b	 Temperature starts to be constant at 10 min – 1m Max temperature remains at 100 °C – 1m	2	
6c	Energy is needed to overcome strong forces of attraction between the particles. Energy is also needed for the gaseous particles to work against atmosphere and escape to the atmosphere.	1 1	

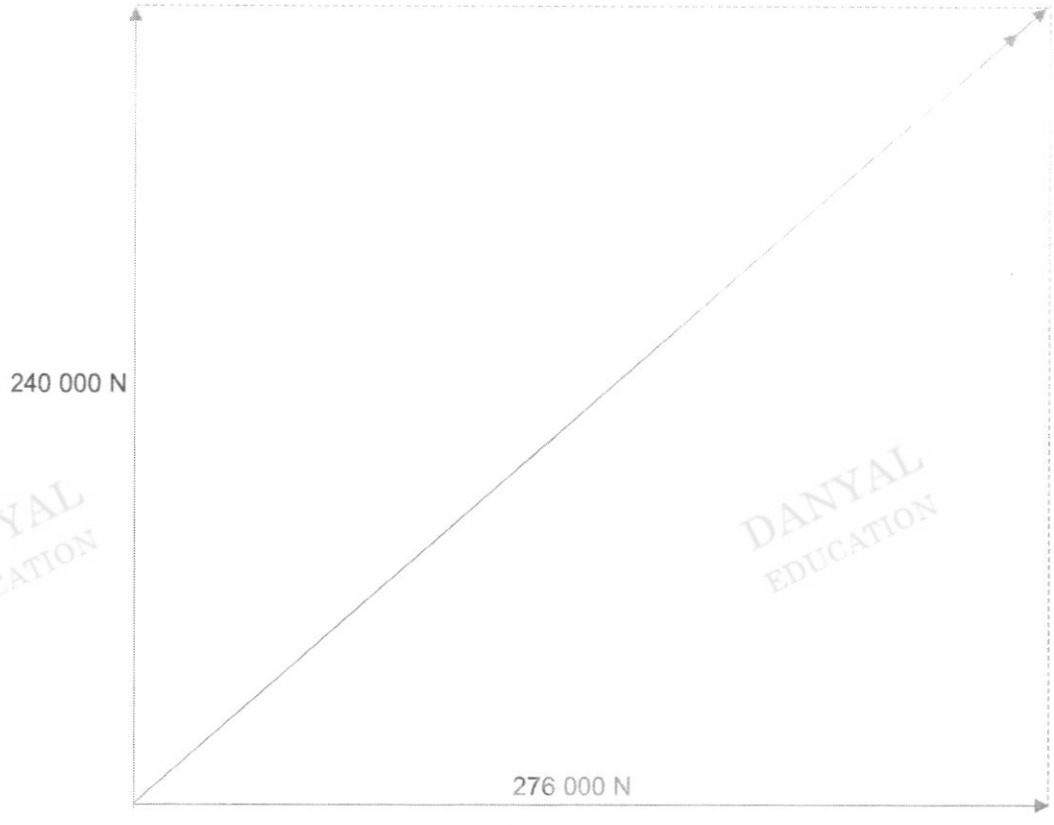
7a	It means that 129 J of energy is needed for 1 kg of gold to change the temperature by 1 °C.	1	
7b	m_s = 1.5 X 0.05 = 0.075 kg E = m$\mathcal{L}_f$ = 0.075 X 105 X 1000 = 7 875 J = 7900 J (2 s.f.)	1 1	
7c	E = mcθ = 0.075 X 235 X (1067 – 30) + m$\mathcal{L}_f$ = 18 280 + 0.075 X 105 X 1000 = 26180 J	1 1	
7d	Check: energy released by freezing gold = m$\mathcal{L}_f$ = 0.95 X 1.5 X 628 X 1000 = 894900 J E = mcθ 26180 = (0.95 X 1.5) X 129 X (θ – 1067) θ - 1067 = 142 θ = 1209 °C	1 1	
8a	Using reversibility of light, $\eta = \frac{\sin r}{\sin i}$ $1.33 = \frac{\sin r}{\sin 40}$ sin r = 0.800 r = 58.7°	1 1	
8b	$\eta = \frac{1}{\sin c}$ $1.33 = \frac{1}{\sin c}$ $\sin c = \frac{1}{1.33} = 0.75$ c = 48.6°	1 1	
8c	Incident angle at 50° is more than critical angle. Light is also travelling from a optically more dense medium to optically less dense medium. Hence, total internal reflection occurs and angle of reflection is equal to angle of incidence	1 1 1	
8d	tan c = r/depth tan 48.6 = r/1.2 r = 1.2 tan 48.6 r = 1.36 m	1 1	Allow ECF
9a	Light travels faster than sound.	1	
9b	The first sound is the sound travelling through the land as speed of sound is higher in solid. The first sound is softer because when sound travels through the land, a lot of energy is lost to the surrounding, hence softer.	1 1	
9c	Average timing = (1.9 + 1.5 + 1.3 + 1.4 + 1.7)/5 = 7.8/5 = 1.56s Speed of sound = 500 / 1.56 = 320 m/s	1 1	
10a	When heated, metal particles gain more thermal energy, hence the particles vibrate more vigorously and start to move away from each other. Hence, the metal expands when heated.	1 1	
10b		1	

	Bend upwards		
10c	1. Identify two fixed points: ice and steam point 2. Marked the positions of two fixed points by measuring the height of the free end from the base of the bimetallic strip. Height of deflection 3. Calibration: the difference in positions divided by difference in temperature OR the more it bends the higher the temperature	1 1 1	
10d	inaccurate, bimetallic setup may be too large, difficult to calibrate Any 1	1	
10e	0 °C - 3840 Ω 100 °C - 190 Ω 60 °C – R $\frac{60-0}{100-0} = \frac{R-3840}{190-3840}$ $\frac{60}{100} = \frac{R-3840}{190-3840}$ $0.6 = \frac{R-3840}{-3650}$ R – 3840 = - 2190 R = 3840 – 2190 R = 1650 Ω	 1 1	
11a	$a = \frac{v-u}{t}$ $= \frac{69-0}{6}$ = 11.5 m/s^2	 1 1	
11b	F = ma = 24000 X 11.5 = 276 000 N	1 1	
11c	W = mg = 24000 X 10 = 240 000 N	 1 1	
11d	Resultant force = 365 000 N Angle between the resultant and the horizontal = 1 m for general shape 1 m for drawing to scale 1m for correct magnitude and angle	3	
11e	½ X 69 X t = 86 t = 2.49 s acceleration = change in speed / time = 69/2.49 = 27.7 m/s^2	 1 1 1	

12Eb	Use a concave mirror	1	
12Eci	High penetrating power to penetrate the body/ Easily absorbed by teeth Cause fluorescence on photographic film	1	
12Eci i	X-rays has high ionising power and can cause changes to biological molecules	1 1	
12Eci ii	$v = f\lambda$ $3 \times 10^8 = 7.0 \times 10^{18} \lambda$ $\lambda = 3 \times 10^8 / 7.0 \times 10^{18}$ $\lambda = 4.29 \times 10^{-11}$ m	 1 1	
12Oa	Orbital speed = $2 \times \pi \times 15.0 \times 10^{10} / 3.16 \times 10^7$ = 29830 m/s = 29.8 km/s	1 1	
12Ob	Greatest distance = $(142 + 287) \times 10^{10}$ = 429×10^{10} m	1	
121O c	Jupiter, Mars and Saturn All 3 planets must be in the answer.	1	
12Odi	Gravitational field strength is defined as the gravitational force acting per unit of mass.	1	
12Odi i	$g = \frac{GM}{r^2}$ $g = \frac{6.67\times10^{-11}\times190\times10^{25}}{(71.5\times10^6)^2}$ = 24.7 N/kg	 1	
12Odi ii	Mass is the amount of substance and hence is independent of location. Thus, mass remains the same. Weight is the force acting on the object due to gravity of the different location. Hence, the astronaut's weight will increase on Jupiter. 1m for differentiating mass and weight 1m for mass is constant 1m for weight to increase on Jupiter	3	

6

11d



12 Ea

A student is having a medical examination.

A dentist checks the student's teeth using a dental mirror made of a plane mirror as shown in Fig. 12.1.

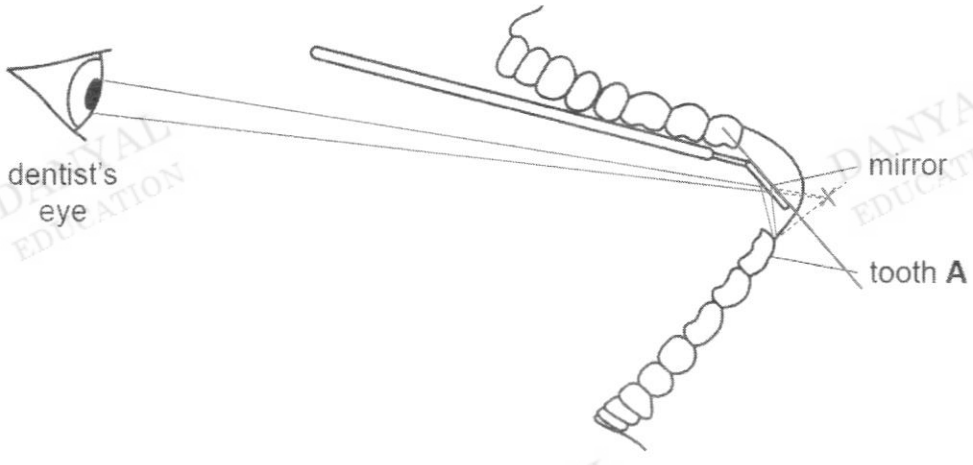


Fig. 12.1