NOTES

DATE:

SEPTEMBER HOLIDAY REVISION

SEC 3 PURE PHYSICS

Instructions:
Please complete your Mock Exam Paper under timed conditions and bring it for class.

CONTENT PAGE

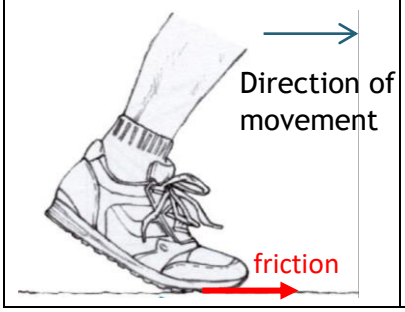
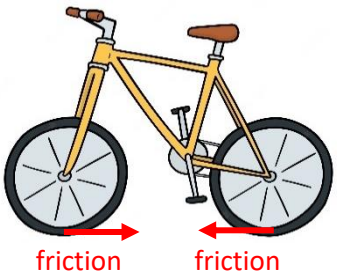
3. DYNAMICS

Definitions

Inertia	the reluctance of a body to change its state of rest or uniform motion in a straight line due to its mass (note: NOT weight!) (greater mass = greater inertia)	
Mass *m* [kg]	measure of the amount of substance in a body	Mass will always remain unchanged while weight can change if the gravitational field strength changes.
Weight [N]	measure of the gravitational force acting on a body due to the gravitational field *g*	
Gravitational field	a region in space where a mass experiences gravitational force due to gravitational attraction	
Gravitational field strength *g* [m/s^2]	gravitational force per unit mass	
Newton's 1st law (don't need to memorise)	an object at rest will remain at rest while an object in motion will remain in motion at constant velocity in a straight line in the absence of an external resultant force	
Newton's 2nd law (don't need to memorise)	the resultant force acting upon an object is equal to the product of the mass and acceleration of the object **F_{net} = ma**	
Newton's 3rd law (don't need to memorise)	for every action, there is an equal and opposite reaction action-reaction forces need to fulfil all 4 criteria: - Equal in magnitude - Act on different bodies - Opposite in direction - Same type of force	
Friction	resistive contact force that exists between any two bodies in contact when their surfaces slide against each other (always opposes relative motion)	

Free body diagram

Note: Friction – can be quite tricky!

Person walking	Free-moving front wheel vs engine-powered back wheel
	

SCALED VECTOR DIAGRAM

Object at equilibrium:	$F_R = 0$ →	Cannot draw resultant line (line with double arrowhead), lines keep going in loops/circle.

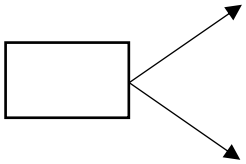
Moving object:	$F_R \neq 0$ →	Can draw resultant line (line with double arrowhead), there is a start point and end point.

TRIANGLE LAW

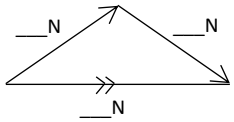
When to use
For any number of quantities (eg. 2 or more forces)

Method
Shift/rearrange the lines (so that the monster has a clear straightforward path to walk)

Question



Answer
Scale
1 cm : ___N



Checklist!

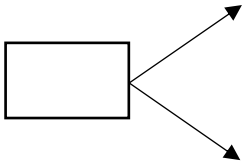
Make sure all are labelled in your drawing:
1) Scale
2) Magnitude (___N)
3) Direction (arrowheads)
4) Angle (from question and your answer)

PARALLELOGRAM LAW

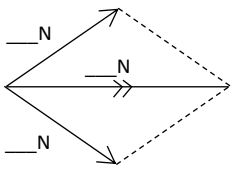
When to use
2 quantities only (2 forces only)
[use Triangle Law if there are more than 2 quantities/forces]

Method
Duplicate the lines (by drawing dotted lines)

Question

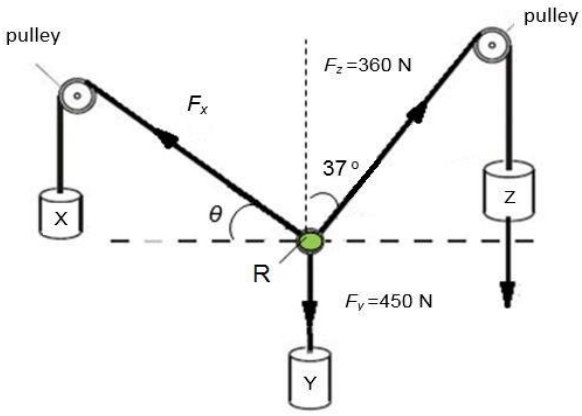
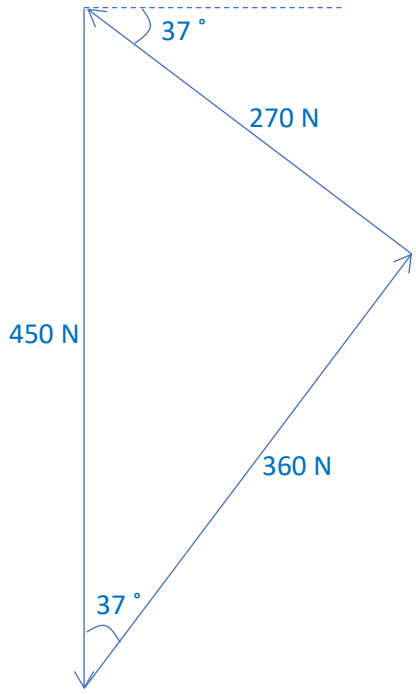


Answer
Scale
1 cm : ___N

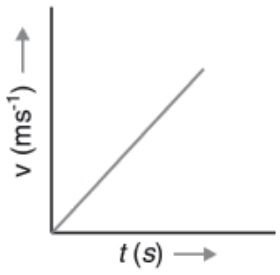
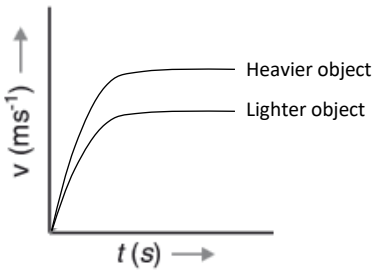


Checklist!

Make sure all are labelled in your drawing:
1) Scale
2) Magnitude (___N)
3) Direction (arrowheads)
4) Angle (from question and your answer)

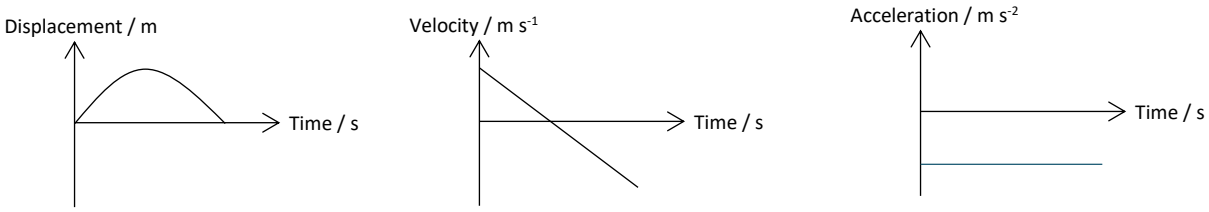
Question	Method
Object at equilibrium / at rest	Draw lines that keep going in loops / circles. Cannot draw resultant line (line with double arrowhead).
The diagram below shows three masses X, Y and Z being supported by three strings that passes through ring R as shown below. Ring R is in equilibrium under the action of three forces F_x, F_y and F_z.  With the aid of a scaled vector diagram, find magnitude of F_x and angle θ . **Checklist!** Make sure all are labelled in your drawing: 1) Scale 2) Magnitude (___N) 3) Direction (arrowheads) 4) Angle (from question and your answer)	Scale 1 cm : 50 N  Magnitude of F_x = 270 N (Acceptable range: 260 N – 280 N) θ = 37 ° (Acceptable range: 36 ° - 38 °)

Object under free-fall

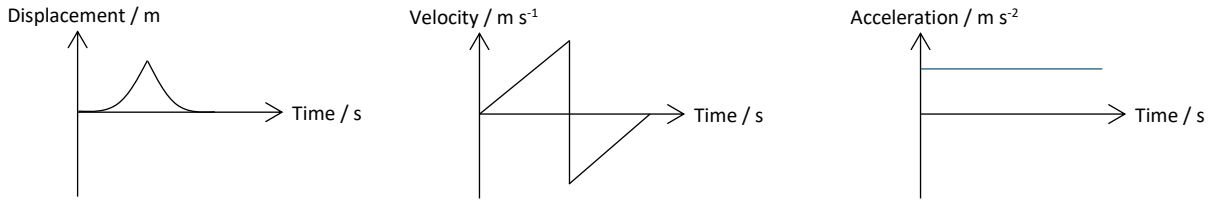
For object falling in mid-air (in absence of air resistance)	For object falling in mid-air (in presence of air resistance)
 	

Common examples on free fall

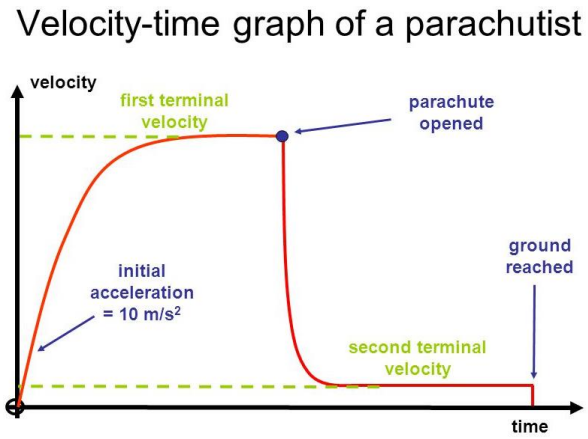
Ball thrown up into the air then back into the hands



Ball released from above the ground then bounce off the floor



Terminal Velocity



Explain the motion of the parachutist.

As he falls, his velocity increases and this causes the air resistance to increase. [1] The downward resultant force decreases and hence, his acceleration decreases. [1]

When the upward air resistance is equal in magnitude to the downward weight of the parachutist, there is no resultant force. [1] There is no acceleration. He falls at terminal velocity. [1]

After the parachutist opens the parachute, the opposing upward air resistance acting on him becomes greater than his downward weight. [1] Resultant force on him becomes negative and he experiences deceleration. [1]

As his velocity decreases, the upward air resistance will decrease until equal to the downward weight of the parachutist, there is no resultant force [1] and no acceleration. He falls at terminal velocity. [1]

4. TURNING EFFECT OF FORCES

Definitions

Moment [Nm]	turning effect of a force. The moment of a force is equal to the product of the force & the perpendicular distance from the line of action of the force to the pivot
Principle of Moments	if a body is in equilibrium, the sum of all clockwise moments about any point must equal the sum of all the anticlockwise moments about the same point
Centre of Gravity (C.G.)	point through which the entire weight of a body appears to act on
Stability	measure of a body's ability to return to its original position after being tilted slightly

Formula

$$Moment = F \times d$$
where d is the perpendicular distance

Principle of moments

When a body is in equilibrium, the sum of clockwise moments about any point is equal to the sum of anti-clockwise moments about the same point.

Calculation template

Taking moments about _____ (pivot),
Sum of anticlockwise moments = Sum of clockwise moments
F × d + W × d = T × d (insert appropriate forces and perpendicular distance)

Take note
<u>For an object to be in **equilibrium**</u>

- Resultant forces must be zero (translational equilibrium)
- Resultant moments must be zero (rotational equilibrium)

<u>For questions **without a pivot**, take either point of suspension as the pivot.</u>
Taking moments at A,

$100N \times 1m + 200N \times 0.5m = T_B \times 2m$

$$\mathbf{T_B = 100\ N}$$

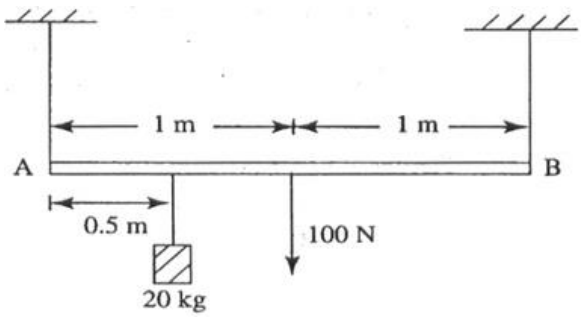
Sum of upward forces = Sum of downward forces

$$T_A + T_B = 200N + 100N$$

$$\mathbf{T_A = 300N - 100N = 200\ N}$$

OR
Taking moments at B,
$100N \times 1m + 200N \times 1.5m = T_A \times 2m$

$$\mathbf{T_A = 200\ N}$$



Centre of Gravity

The centre of gravity of an object is the point through which the entire weight of the object seems to act.

Stability

Stable equilibrium	Unstable equilibrium	Neutral equilibrium
An object in stable equilibrium returns to its original position after being slightly displaced as the line of action of its weight still passes through its base area.	An object in unstable equilibrium moves further away from its original position after being slightly displaced as the line of action of its weight lie outside its base area.	An object in neutral equilibrium adopts the new position to which it has been displaced as the centre of gravity remains at the same height and line of action of its weight remains directly above its base area.

Answering technique

- line of action of its weight lies within/outside its base area
- producing a/an clockwise/anti-clockwise moment about _____ (pivot)

Factors affecting stability

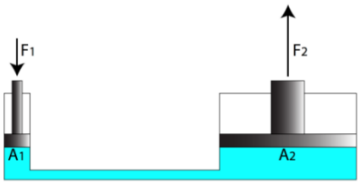
- Height of centre of gravity:
  Lower centre of gravity of the body → stability ↑
- Size of base area of the body:
  ↑ body's base area →stability ↑

5. PRESSURE

Definitions

Pressure [N/m^2 or Pa]	force per unit area
Atmosphere pressure	force per unit area exerted against a surface by the weight of the air above that surface

Formulas

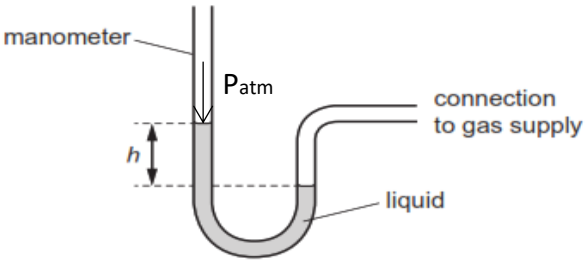
$\rho = \frac{m}{V}$	**Converting units:** 1 g cm^{-3} = 1000 kg m^{-3} 1 kg m^{-3} = 0.001 g cm^{-1}	
$P = \frac{F}{A}$	$P = \frac{F_1}{A_1} = \frac{F_2}{A_2}$ $WD = F_1 d_1 = F_2 d_2$ $V_{left} = V_{right}$ A x h = A x h	For hydraulic system, 
$P_{fluid} = \rho g h$	For fluid pressure exposed to air, $P_{Total} = P_{fluid} + P_{atm}$	$P_{atm} = 101\ kPa = 76\ cm\ Hg$

Atmospheric Pressure

P_{atm} = 1.01 x 10^5 Pa = 76 cm Hg = 1 atm

U-Tube Manometer

U-tube manometer is used to measure the pressure due to a gas (when atm is known). The difference in gas pressure and atmospheric pressure is the excess pressure.



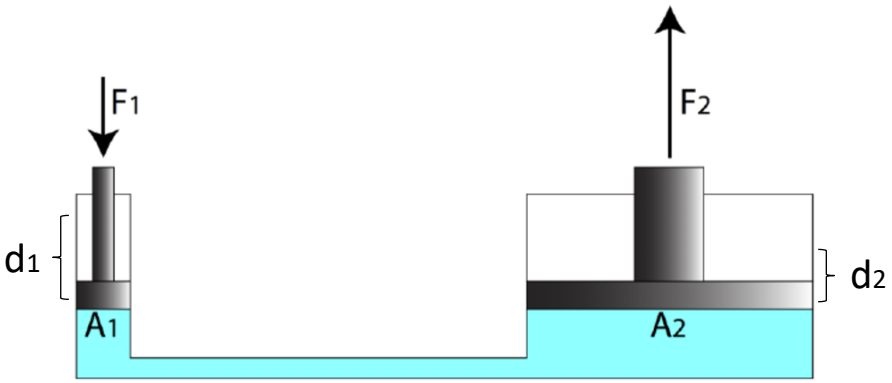
$P_{left} = P_{right}$

$P_{atm} + P_{Hg} = P_{gas}$

If question is asking for answers in terms of cm Hg, just use the lengths (cm) for calculation, don't need to use the formula of P = ρgh.

Hydraulic System

A hydraulic system multiplies the effort so a small effort can be used to lift a much greater load.



Pressure throughout the liquid is equal.

$$P_{left} = P_{right}$$
$$F / A = F / A$$

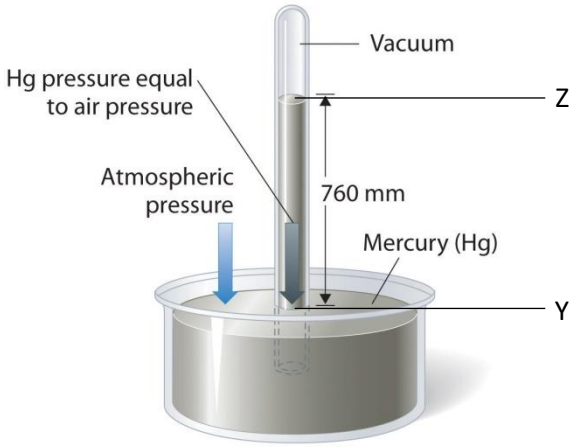
Volume of water is equal.

$$V_{left} = V_{right}$$
$$A \times h = A \times h$$

Work done is equal.

$$WD_{left} = WD_{right}$$
$$F \times d = F \times d$$

MERCURY BAROMETER



A simple mercury barometer measures atmospheric pressure. The volume of mercury in the column will increase or decrease with changes in atmospheric pressure such that Pressure at y = Height of X

State and explain what happens to the mercury column in the barometer when:

More mercury is poured into the pool	The mercury column level will rise by the same amount to maintain the column height h since pressure, density and g remains constant.
The glass tube is tilted	Perpendicular height of mercury column to the surface of the pool of mercury is unchanged as pressure is dependent on the vertical height and not the length of the column.
The glass tube is pushed deeper into the trough	The height of the mercury column will not change. The atmospheric pressure remains the same.
Water is introduced into the space above the mercury column	Mercury height column decreases as water presses downwards on the mercury column.
There is a crack in the glass tube	Height of mercury decreases to the same level as the pool of mercury as air will move from outside the tube (a higher pressure region) to inside (lower pressure) until the pressure difference inside and outside the tube is zero.

END OF YEAR MOCK EXAMINATION
SECONDARY THREE
BASED ON 2024 SEAB SYLLABUS

PHYSICS **6091/01**

Paper 1

September 2024
30 minutes

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.

There are **twenty** 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 Optical Answer Sheet.

Fill in the Optical 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 question paper.
The use of an approved scientific calculator is expected, where appropriate.

Shade the corresponding lozenge.

Total score: _____

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

Question 1

Which pair contains two equivalent measurements?

	measurement 1	measurement 2
(A)	2000 Hz	20 kHz
(B)	7.2×10^5 μA	7.2×10^{-1} A
(C)	3500 cm^2	35 m^2
(D)	6900 ms	0.69 s

Question 2

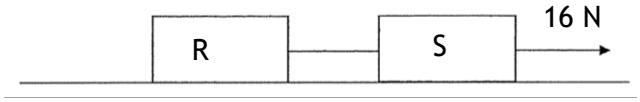
A motorist is travelling on a straight road at a speed of 20 m/s. She sees the traffic light ahead turn red and decelerates uniformly. She travels a distance of 50 m from the time she starts decelerating to when she comes to a stop. How much time does the motorist take to come to a stop?

(A) 0.8 s (B) 1.3 s

(C) 2.5 s (D) 5.0 s

Question 3

A 16 N force acts on block R of mass 6kg and block S of 2 kg as shown in the figure. Assuming that the floor is frictionless, what is the tension in the string between blocks R and S?



(A) 6 N (B) 12 N

(C) 16 N (D) 48 N

Question 4

Which row describes an action-reaction pair of forces?

	action	reaction
(A)	a force pushing a book along the surface of a table	a frictional force acting on the book as it is being pushed
(B)	the weight of a skydiver freefalling through the air	the gravitational force by the skydiver on the Earth
(C)	the weight of a simple pendulum swinging freely	the tension in the string attached to the pendulum bob
(D)	a man exerting a force to pull a door handle	the normal contact force from the man's hand on the door

Question 5

A man pushes a heavy box along a horizontal ground at a constant speed of 1 m/s.

Which statement correctly describes the forces acting on the box?

(A) The friction between the box and the ground is less than the force exerted by the man on the box.

(B) The friction between the box and the ground is equal to the force exerted by the man on the box.

(C) The friction between the box and the ground is greater than the force exerted by the man on the box.

(D) There is no friction between the ground and the box.

Question 6

An initial upward force of 3800 kN is exerted on a rocket of mass 327×10^3 kg at launch. Air resistance is negligible and gravitational field strength is 10 N/kg.

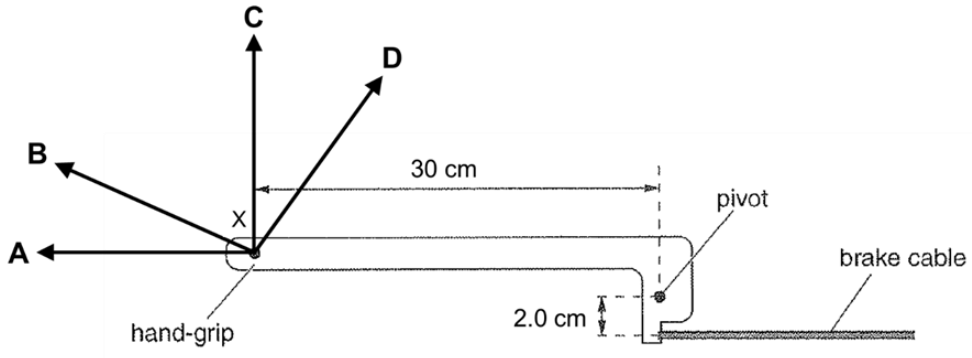
What is the initial acceleration of the rocket at launch?

(A) 1.16 m/s^2 (B) 1.62 m/s^2

(C) 10.0 m/s^2 (D) 11.6 m/s^2

Question 7

The diagram shows a handbrake in a car. A force of 40 N is to be applied at point X on the hand grip of the handbrake.



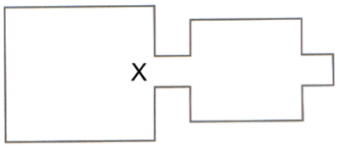
Which force will generate the greatest moment about the pivot?

(A) A (B) B

(C) C (D) D

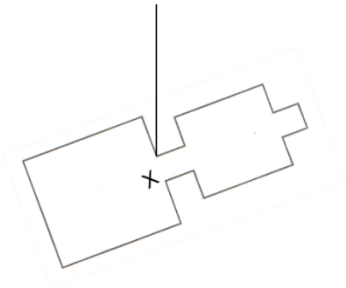
Question 8

A lamina of uniform thickness and uniform density has its centre of gravity marked with cross 'X'.

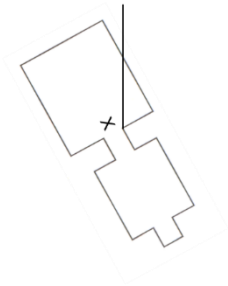


Which figure shows how the lamina will hang when suspended from a single string?

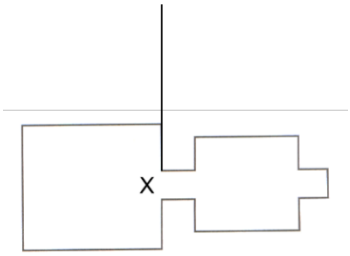
(A)



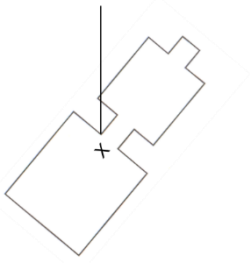
(B)



(C)

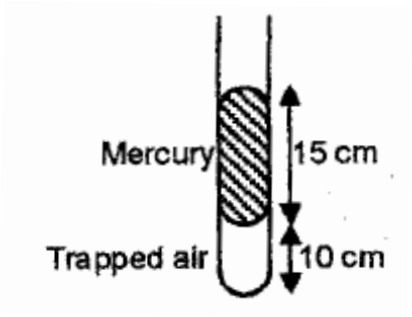


(D)



Question 9

The diagram shows air trapped in a narrow tube sealed at one end. When the atmospheric pressure is 75 cm Hg, the length of the trapped air column is 10 cm and the length of the mercury column is 15 cm as shown below.



Assuming temperature is kept constant throughout, what is the pressure of the trapped air?

(A) 60 cm Hg

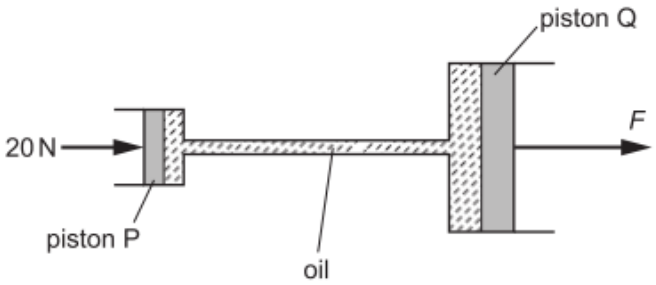
(B) 85 cm Hg

(C) 90 cm Hg

(D) 100 cm Hg

Question 10

The diagram shows a simplified model of a car hydraulic brake system.

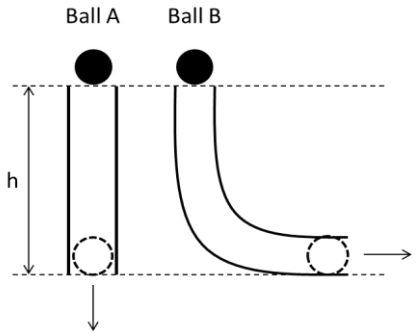


If the force exerted by piston Q is F = 840 N, which are possible areas of pistons P and Q?

	area of piston P / cm^2	area of piston Q / cm^2
(A)	2	82
(B)	4	168
(C)	6	264
(D)	8	384

Question 11

Two identical spherical balls are dropped from rest from the same height, h, into two differently shaped tubes.



Given that the effects of air resistance and friction are negligible, which statement about the kinetic stores of the two balls is correct?

(A) The kinetic store of Ball A is greater than Ball B because it falls through a greater vertical distance faster.

(B) The kinetic store of Ball B is greater than Ball A because it falls through a greater distance of tube.

(C) The kinetic stores of Ball A and Ball B are equal because they fall through the same height.

(D) The kinetic stores of Ball A and Ball B are equal because kinetic energy is not dependent on height.

Question 12

A toy boat is propelled steadily from rest to reach a speed of 1.5 m/s in 10 seconds. During this time, there is an average water resistance of 2.0 N.

What is the ~~rate of~~ work done against the water resistance?

(A) 15 J
(B) 30 J
(C) 150 J
(D) 300 J

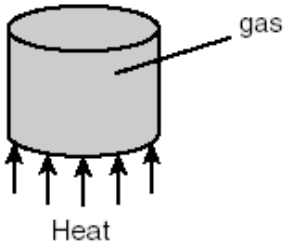
Question 13

Which statement correctly describes an example of Brownian motion?

(A) Molecules of a liquid moving about randomly.
(B) Molecules of a solid vibrating about their fixed positions.
(C) Pollen grains suspended in water moving about randomly.
(D) Smoke particles in the air gradually falling to the ground

Question 14

A gas in a sealed rigid cylinder is heated.

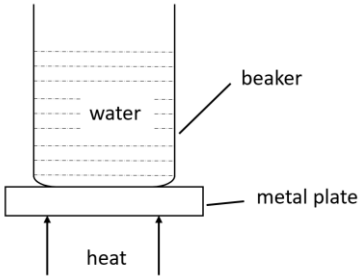


Which of the following does ***not*** happen as the gas is heated?

(A) The average distance between the gas molecules increases.
(B) The average kinetic energy of the gas molecules increases.
(C) The average number of gas molecules hitting the cylinder walls per second increases.
(D) The average number of gas molecules hitting the cylinder walls per second increases.

Question 15

Four beakers containing the same amount of water at the same temperature are placed on hot metal plates. The lower surfaces of the metal plates are kept at the same temperature. The plates are all the same size but are made from four different metals. The times taken to produce stated temperature rises are given below.



Which metal is the poorest thermal conductor?

	time / s	temperature rise / °C
(A)	100	8
(B)	150	10
(C)	200	15
(D)	250	18

Question 16

The heat from the hot water in a metal radiator passes through the metal and then spreads around the room.

(image credit:betterbathrooms.com)

What are the main processes by which the heat is transferred through the radiator and then spread around the room?

	through the metal radiator	around the room
(A)	conduction	convection
(B)	conduction	radiation
(C)	radiation	convection
(D)	radiation	radiation

Question 17

Hot water at 100°C is added to 5 g of ice at 0°C.

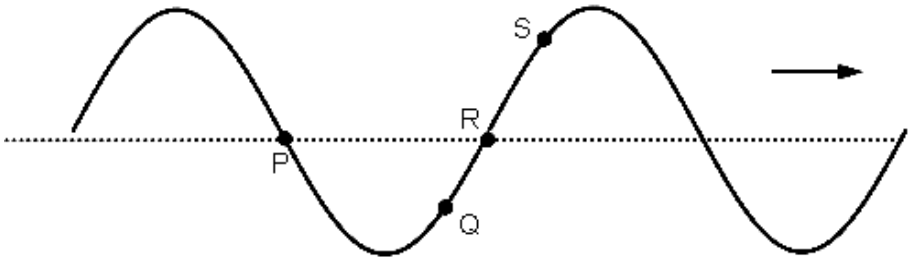
What is the minimum mass of hot water needed to melt the ice?

[Specific latent heat of fusion of ice is 336 J/g, Specific heat capacity of water is 4.2 J g^{-1} K^{-1})]

(A) 0.8 g
(B) 4.0 g
(C) 16.8 g
(D) 70.6 g

Question 18

The diagram below shows the profile of part of a wave moving from left to right on a piece of string. P, Q, R and S represent various points along the piece of string.



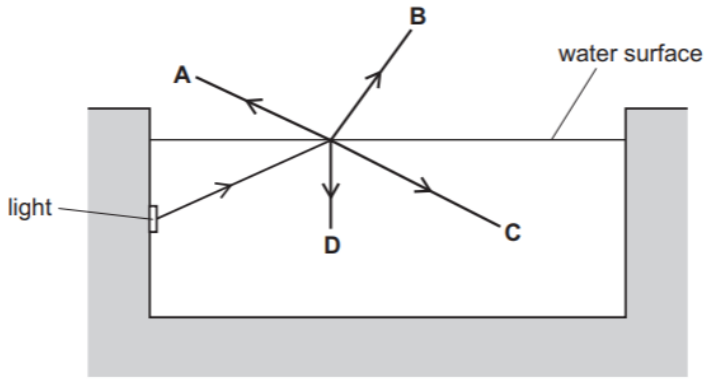
Which statement is true?

(A) P is permanently at rest.
(B) S is moving upwards at this instance.
(C) Q is moving downwards at this instance.
(D) P and R are moving in the same direction.

Question 19

The diagram shows a swimming pool lit by an underwater light.

A ray of light is incident on the water surface.



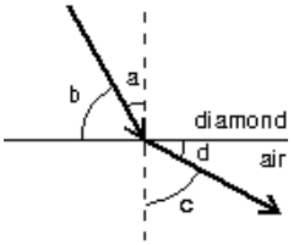
What is the correct path of the ray of light?

(A) A (B) B

(C) C (D) D

Question 20

The refractive index of diamond is 2.5.



Which statement shows the correct relationship between the angles?

(A) $\frac{\sin a}{\sin c} = 2.5$ (B) $\frac{\sin c}{\sin a} = 2.5$

(C) $\frac{\sin c}{\sin a} = 2.5$ (D) $\frac{\sin d}{\sin b} = 2.5$

END OF YEAR MOCK EXAMINATION
SECONDARY THREE
BASED ON 2024 SEAB SYLLABUS

PHYSICS **6091/02**

Paper 2 September 2024

40 minutes

READ THESE INSTRUCTIONS FIRST

Write in dark blue or black pen.
You may use a pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Answer **all** questions in the spaces provided.

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

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

SCORE

Paper 1		20
Paper 2		30
TOTAL		50

Write your answers in the spaces provided.

Question 21

Fig. 21.1 shows a circus performer walking on a tightrope. At the point where she is standing, her body is in equilibrium.

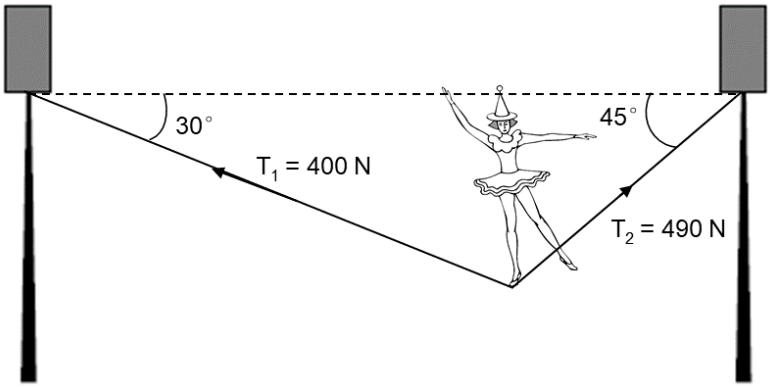


Figure 21.1

(a) By using a suitable scale, draw a labelled diagram to determine the magnitude of the resultant force of T_1 and T_2. [3]

(b) Hence or otherwise, determine the weight of the circus performer. [1]

Question 22

A boy on a skateboard moves in a straight line. He starts from rest and eventually comes to a stop some distance away from where he started.

Fig. 22.1 show the speed-time graph of the boy.

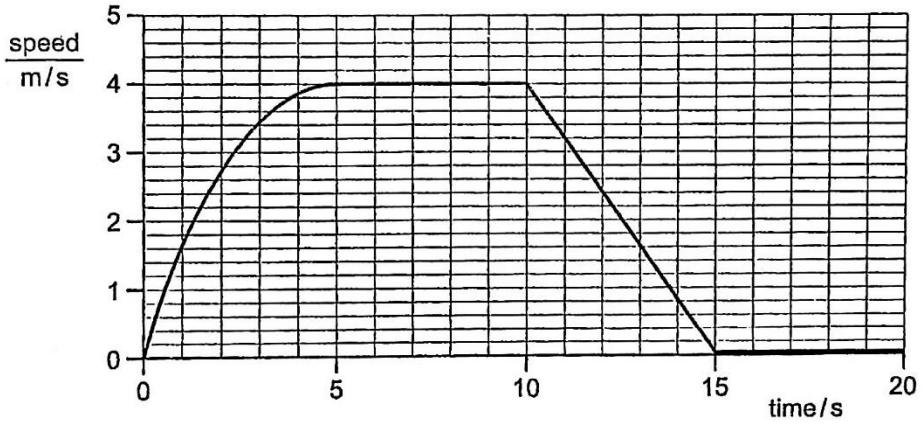


Figure 22.1

(a) Using information from Fig. 22.1, describe the motion of the boy between t = 0 s to t = 10 s. [2]

(b) At t = 10 s, the boy begins to move with uniform deceleration.

Calculate the distance travelled by the boy during uniform deceleration. [1]

Question 23

Fig. 23.1 shows a weather balloon immediately after take-off. The balloon is drifting upwards in the air. The balloon experiences an upward force of 50 N. The weight of the balloon is 20 N. The gravitational field strength *g* is 10 N/kg.

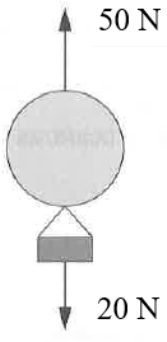


Figure 23.1

(a) Determine the mass of the balloon. [1]

(b) Calculate the initial vertical acceleration of the balloon. [2]

(c) The upward force remains at 50 N. Air resistance increases to 40 N as the balloon continues to rise.

Describe and explain the motion of the balloon when the air resistance reaches this value. [2]

Question 24

Fig. 24.1 shows a simplified diagram of a paper hole-puncher. A force of 6.0 N is applied vertically downwards on the lever to punch a hole in a piece of paper, but friction f acts on the knife and cannot move downwards even as the 6.0 N is continuously applied.

The lever weighs 1.0 N, and the weight of the knife is negligible.

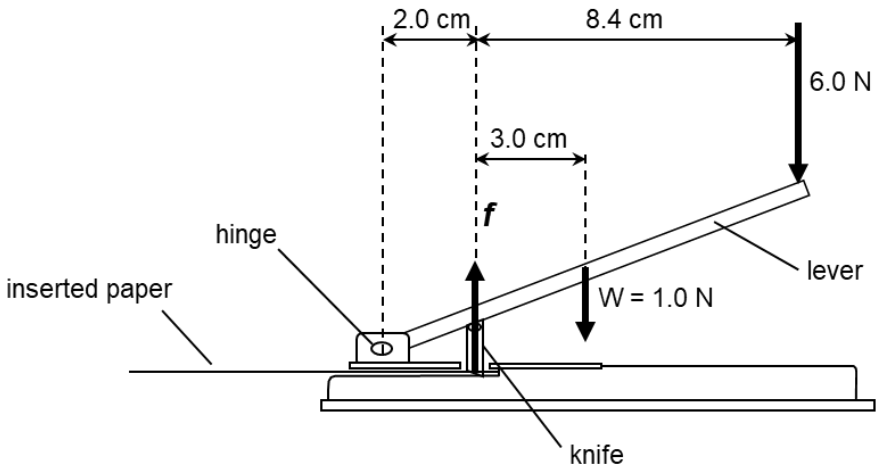


Figure 24.1

(a) State the principle of moments. [1]

(b) By using the principle of moments, calculate the friction ***f***. [1]

(c) State and explain whether the moment due to the 6.0 N force increases, decreases or remains the same as the lever of the hole puncher is pushed down. [2]

Question 25

Two identical barometers A and B are set up at sea level next to each other as shown in Fig. 25.1. The space above the mercury column in barometer A is vacuum.

The density of mercury is 1.36×10^4 kg/m^3 and g is 10 N/kg.

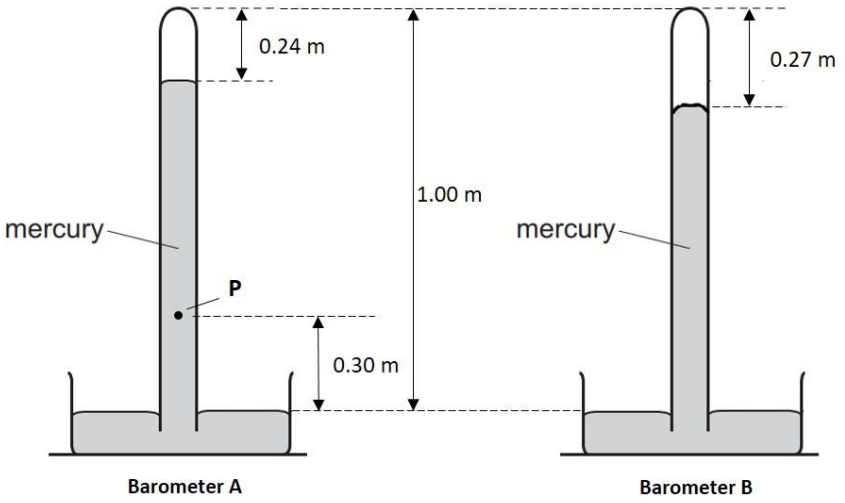


Figure 25.1

(a) State the atmospheric pressure measured by barometer A in cm Hg. [1]

(b) Determine the pressure at point P. Leave your answer in Pa. [2]

(c) Suggest a reason why the space above the mercury column in barometer B is bigger than that in barometer A. [1]

(d) If the diameter of barometer A is doubled, explain any change to the height of the mercury column. [2]

Question 26

Fig. 26.1 shows the boiler of a coal-fired power station. Hot gases rise and energy is transferred to the water inside the metal pipes.

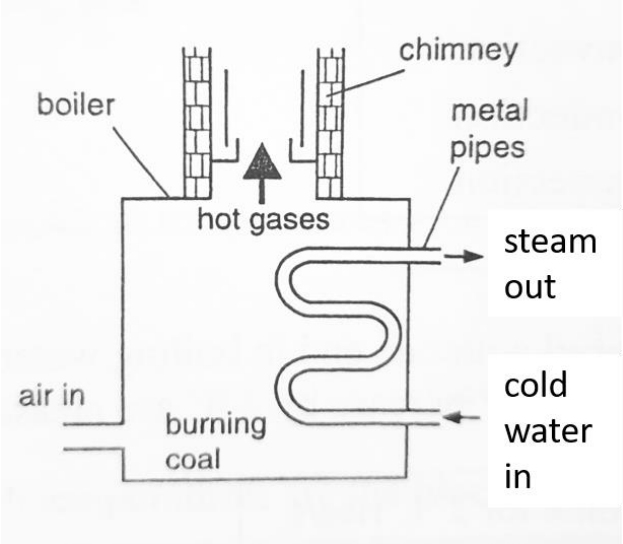


Figure 26.1

Describe how energy passes through the metal pipes to warm up the water inside. [3]

Question 27

Fig. 27.1 shows an object AB near a thin converging lens. The path of one ray from point **A**, passing through the lens, is drawn.

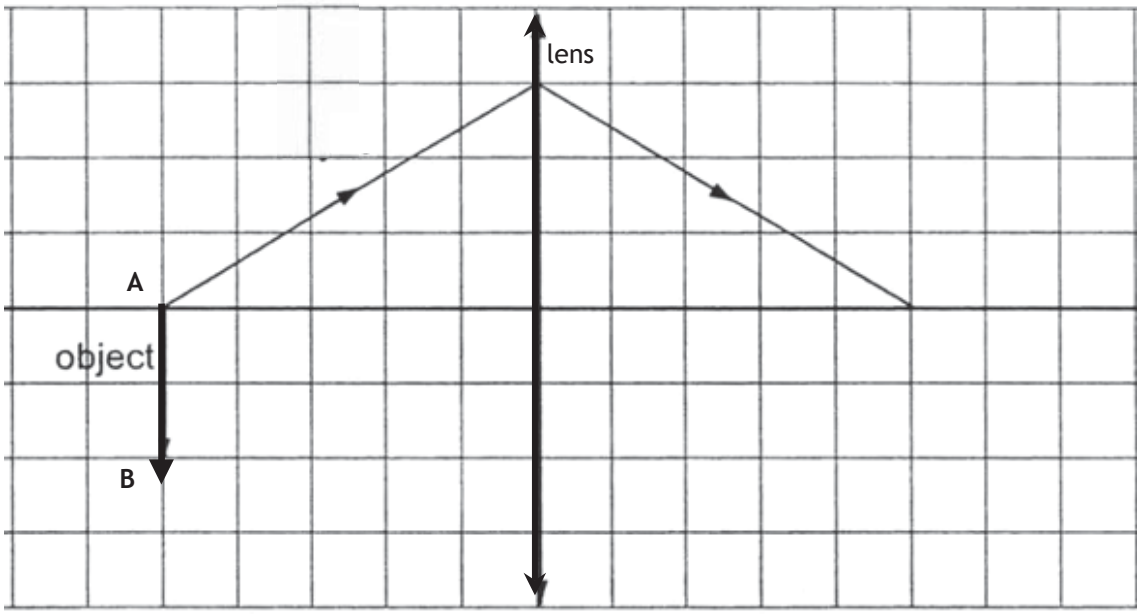


Figure 27.1

(a) On Fig. 27.1, draw a suitable ray from point B, passing through the lens, to locate the position of the image of object AB. Label the image A'B'. [2]

(b) By drawing another ray from point B passing through the lens, mark the focal length of the lens. Label it as **f**. [1]

(c) The converging lens may be used to form a virtual image of object AB. State where the object is placed, relative to the lens, for a virtual image to be formed. [1]

_____

(d) If the top half of the converging lens is removed, state and explain whether the image is still formed. [1]

_____

_____

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Bukit Timah	Wednesday	7.30PM-9.30PM
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