



Basic Education

KwaZulu-Natal Department of Education
REPUBLIC OF SOUTH AFRICA

PHYSICAL SCIENCES: PHYSICS (P1)

COMMON TEST

JUNE 2016

**NATIONAL
SENIOR CERTIFICATE**

GRADE 11

MARKS: 100

TIME : 2 hours

This question paper consists of 10 pages, 1 data sheet and 1 graph sheet.

INSTRUCTIONS AND INFORMATION

1. This question paper consists of EIGHT questions.
2. Answer ALL the questions in the ANSWER BOOK.
3. Number the answers correctly according to the numbering system used in this question paper.
4. Leave ONE line between two sub-questions, for example between QUESTION 2.1 and QUESTION 2.2.
5. You may use non-programmable calculator.
6. You may use appropriate mathematical instruments.
7. You are advised to use the attached DATA SHEETS.
8. Show ALL formulae and substitutions in ALL calculations.
9. Round off your FINAL answers to a minimum of TWO decimal places.
10. Give brief motivations, discussions, et cetera where required.
11. Write neatly and legibly.

QUESTION 1: MULTIPLE- CHOICE QUESTIONS

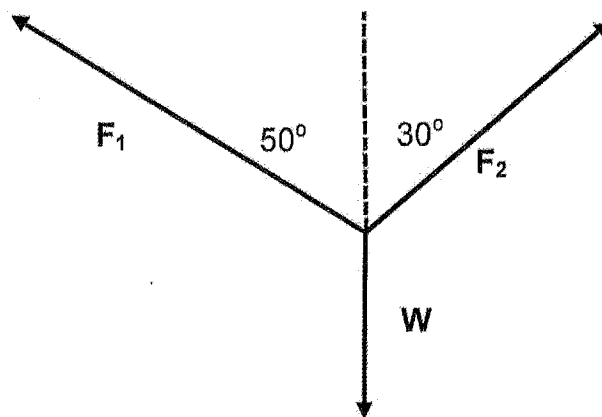
Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A – D) next to the question number (1.1 – 1.6) in the ANSWER BOOK, for example 1.1 D

1.1 Two vectors act at the same point on an object. A maximum resultant vector is obtained when the angle between these two vectors is...

- A 0°
- B 90°
- C 180°
- D 45°

(2)

1.2 A block of weight W is suspended from two strings. F_1 and F_2 are the forces exerted by the strings on the block in the directions shown in the figure below.



If the block is in a state of equilibrium, which one of the following equations is valid for this situation?

- A $W = (F_1)^2 + (F_2)^2$
- B $F_1 \sin 50^\circ = F_2 \sin 30^\circ$
- C $F_1 \cos 50^\circ = F_2 \cos 30^\circ$
- D $W = F_1 + F_2$

(2)

1.3 A ball is dropped onto a concrete floor and bounces off the floor. Which ONE of the following laws **best** explains why the ball experiences an upward force?

- A Newton's first law of motion
- B Newton's second law of motion
- C Newton's third law of motion
- D Newton's law of universal gravitation

(2)

- 1.4 A block of mass m experiences a frictional force, f_k , while it is being pulled at a constant velocity along a horizontal surface of coefficient of kinetic friction equal to μ_k . When the same block is allowed to move at a constant velocity down an inclined plane of the same material, the coefficient of kinetic friction and the frictional force it will now experience is:

	Coefficient of kinetic friction	Frictional force
A	Equal to μ_k	Equal to f_k
B	Equal to μ_k	Less than f_k
C	Greater than μ_k	Greater than f_k
D	Less than μ_k	Less than f_k

(2)

- 1.5 Two objects of mass m and $2m$ placed at a distance r metres apart exert a force F on each other. The distance between these two objects is now halved. The force that the $2m$ mass exerts on the m mass is equal to:

- A $2F$
 B F
 C $\frac{1}{2}F$
 D $4F$

(2)

- 1.6 Refraction will occur when a monochromatic light ray travels from an optically less dense medium to an optically dense medium. Which combination for speed, wavelength and frequency of the refracted wave is correct?

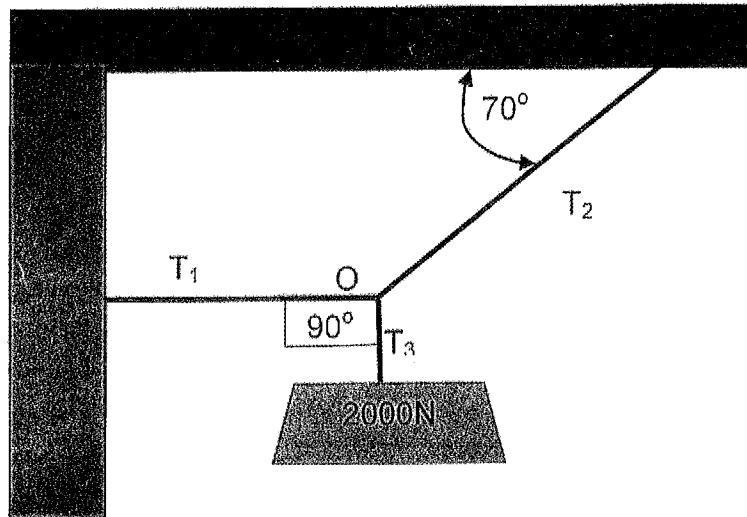
	Speed	Wavelength	Frequency
A	Increase	Increase	Increase
B	Decrease	Decrease	Remain constant
C	Increase	Increase	Remain the same
D	Decrease	Decrease	Increase

(2)

[12]

QUESTION 2

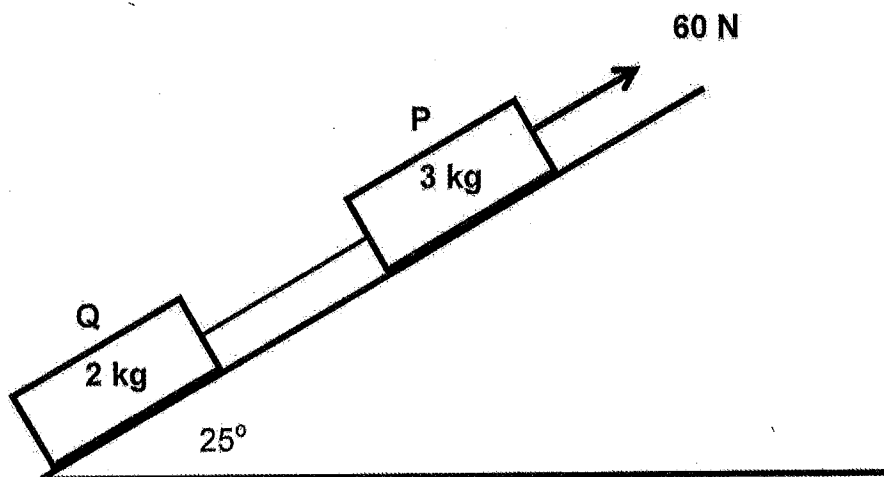
The structure below shows a system that is in a state of equilibrium. The strings with forces T_1 , T_2 and T_3 , are joined at point O. The weight of the block suspended from T_3 is 2000 N.



- 2.1 What is the difference between a scalar and a vector quantity? (2)
- 2.2 What is the resultant force acting on the block? Give a reason. (2)
- 2.3 Draw a labelled CLOSED VECTOR DIAGRAM OF FORCES showing all the forces acting at point O (Indicate TWO angles in your diagram). (4)
- 2.4 Determine, by means of calculation, the magnitude of the forces T_1 , T_2 and T_3 . (6)
- [14]**

QUESTION 3

The diagram below shows a 3 kg block connected to a 2 kg block by a light inextensible string. A constant force of 60 N acts upwards along the plane as shown in the diagram.



The frictional force between the blocks P and Q and the surface is 2 N and 1 N respectively as the blocks move.

- 3.1 State, in words, Newton's Second Law of Motion. (2)
- 3.2 Draw a labelled free body diagram showing:
- 3.2.1 all the forces acting on the 3 kg block. (5)
- 3.2.2 the forces acting along the plane on the 2 kg block. (2)
- 3.3 Calculate the magnitude of the acceleration of the 3 kg block. (6)
- 3.4 Hence, determine the magnitude of the tension in the string. (2)
- 3.5 The mass of block P is increased to 6 kg. How will this affect the following?
- 3.5.1 Coefficient of kinetic friction for block P. (1)
- 3.5.2 Acceleration of the system. (1)
- 3.5.2 The tension in the string. (1)
- (Choose from INCREASE, DECREASE OR REMAINS THE SAME)**
- 3.6 How will the tension in the string be affected when the 60 N force is now removed? (1)

[21]

QUESTION 4

A girl stands on a bathroom scale in a stationary lift. The scale is calibrated in Newtons.

- 4.1 State in words, Newton's Third Law of motion. (2)
- 4.2 How will the scale reading change when the lift accelerates upwards?
(Choose from **INCREASE, DECREASE OR REMAINS THE SAME**)
Explain. (3)
- 4.3 When will the scale reading be 0,00 N with the girl still standing on it?
(The scale is not broken). (2)
- [7]

QUESTION 5

A man of mass 70 kg is on the surface of the Earth.

- 5.1 State Newton's Law of Universal Gravitation in words. (2)
- 5.2 Prove, showing all your workings, that the acceleration due to gravity is given by: $g = GM_E/r^2$. (4)
- 5.3 Calculate the acceleration due to gravity if the man is now on the surface of a planet of mass 4 times that of the Earth, but with the same radius as that of the Earth. (2)
- 5.4 How will the answer in question 5.3 change if a man of 50 kg was on this planet?
Choose from **INCREASE, DECREASE or STAYS THE SAME**. (1)
- [9]

QUESTION 6

Learners perform an experiment to determine the refractive index of glass. They direct a narrow beam of light from a ray box such that it strikes the air – glass interface obliquely (at an angle other than 90°). They repeat this procedure at various angles of incidence, each time measuring the angle of refraction. Their results are shown in the table below.

Angle of incidence (i)	Angle of refraction (r)	$\sin i$	$\sin r$
15	10		
25	16		
45	28		
55	33		
60	35		
65	39		

6.1 For this experiment, write down:

- 6.1.1 the dependent variable (1)
 6.1.2 the independent variable (1)
 6.1.3 one controlled variable (1)

6.2 Complete the table and then draw an appropriate graph of the data in the table and use it to obtain the refractive index of the glass material.

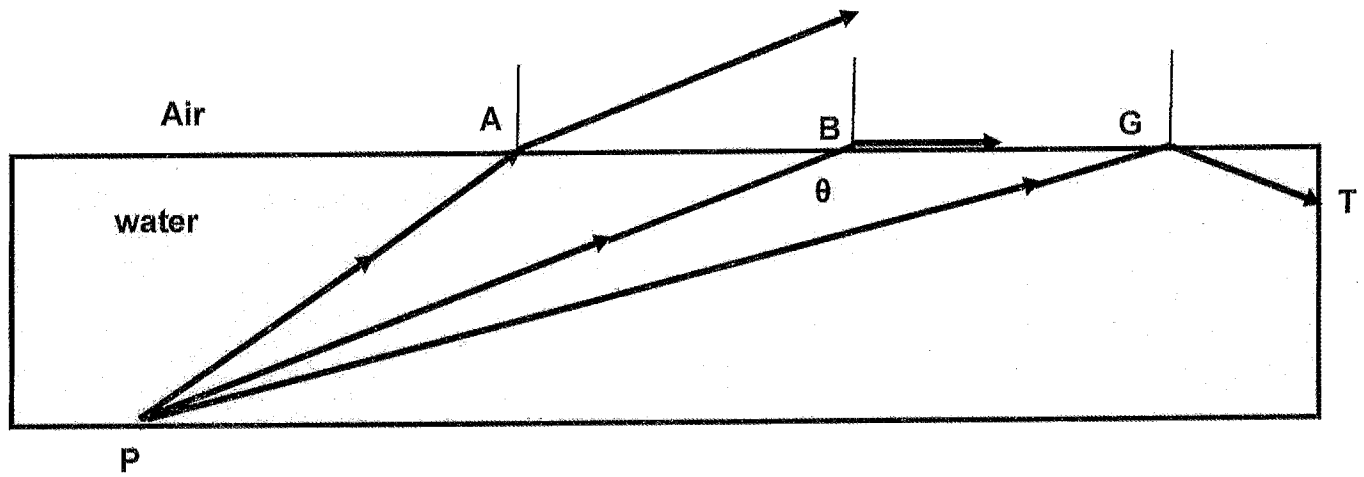
USE THE GRAPH PAPER ATTACHED TO YOUR QUESTION PAPER TO ANSWER THIS QUESTION. (11)
 (take the refractive index of air to be 1)

6.3 Use the result in QUESTION 6.2 to calculate the speed of light through the glass material. (3)

[17]

QUESTION 7

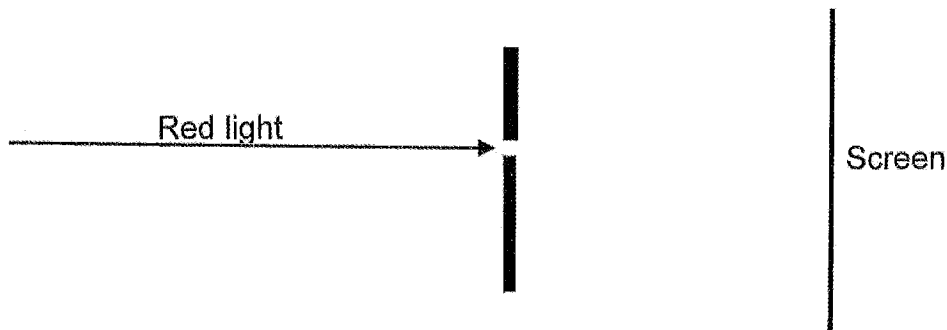
The sketch below shows three light rays which move from point P at the bottom of a big glass tank that contains water.



- 7.1 What is the phenomenon that occurs when the ray of light reaches the interface at A? (1)
 - 7.2 What does angle θ represent? (1)
 - 7.3 What is the phenomenon represented by light ray PGT? (1)
 - 7.4 State two conditions necessary for the phenomenon in question 7.3. (2)
 - 7.5 Give one use of the phenomenon in question 7.3 in medicine. (1)
- [6]**

QUESTION 8

The sketch below shows a beam of red light passing through a narrow slit. A diffraction pattern is observed on the screen.



- 8.1 Define the term diffraction. (2)
- 8.2 Describe the diffraction pattern that would be observed on the screen. (3)
- 8.3 Use Huygen's principle to explain the pattern observed in question 8.2. (3)

- 8.4 Suppose the red light is now replaced by blue light. State two observable changes to the pattern described in question 8.3 above. (2)
- 8.5 How will the diffraction pattern be affected if the width of the slit is narrowed? (2)
- 8.6 What does diffraction and interference of light prove about light? (2)

[14]**TOTAL MARKS: [100]**

DATA FOR PHYSICAL SCIENCES P1 GRADE 11

TABLE 1: PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Acceleration due to gravity	G	9.8 m.s ⁻¹
Speed of light in a vacuum	c	3.0 x 10 ⁸ m.s ⁻¹
Gravitational constant	G	6.67 x 10 ⁻¹¹ N.m ² .kg ⁻²
Mass of Earth	M _{Earth}	5.98 x 10 ²⁴ kg
Radius of Earth	R _{Earth}	6.38 x 10 ⁶ m

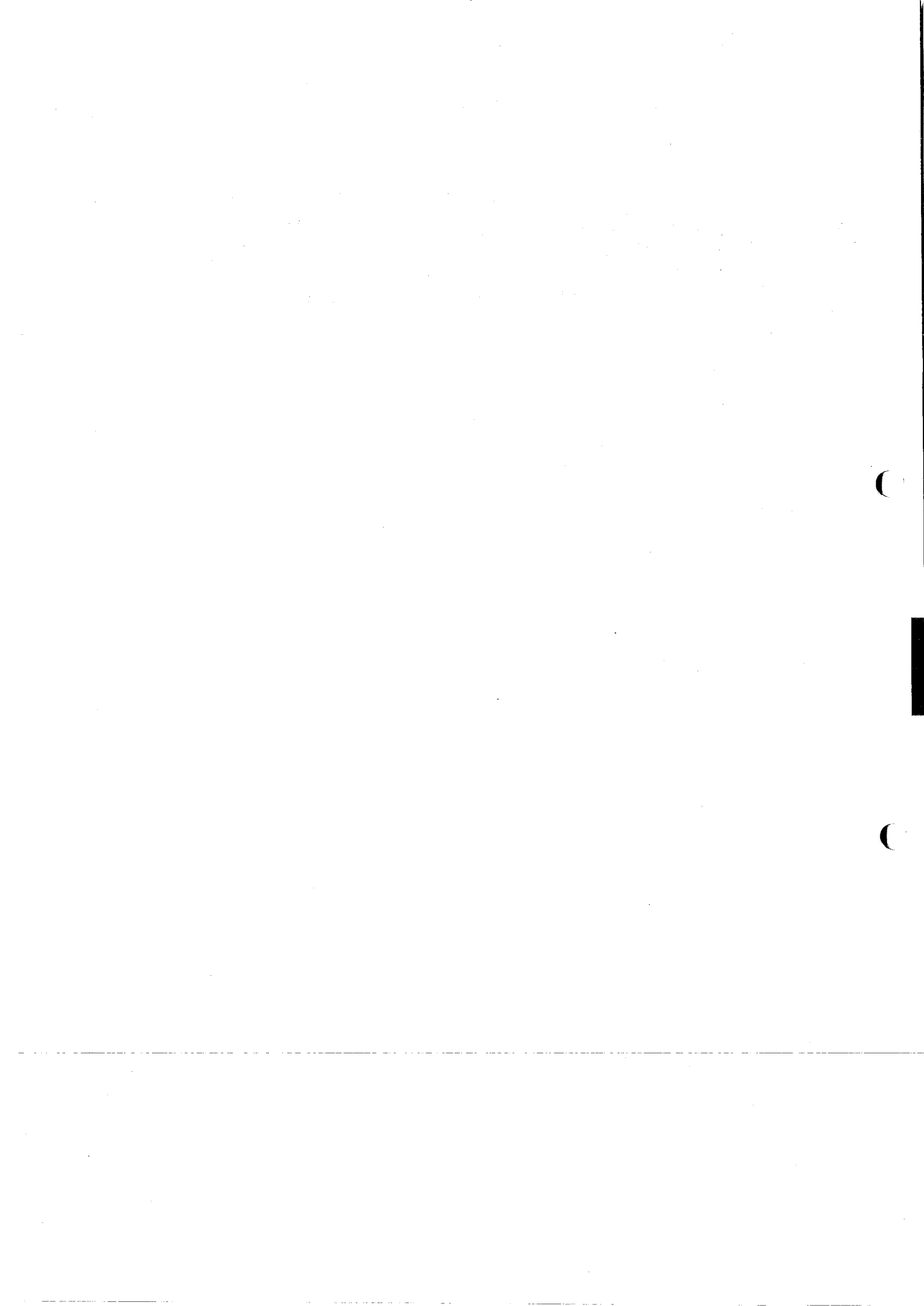
TABLE 2: FORMULAE

MECHANICS

$F_{net} = ma$	$F_g = mg$
$F = GMm / r^2$	$g = GM / r^2$
$\mu_k = f_k / N$	$\mu_s = f_{s(max)} / N$

WAVES, LIGHT AND SOUND

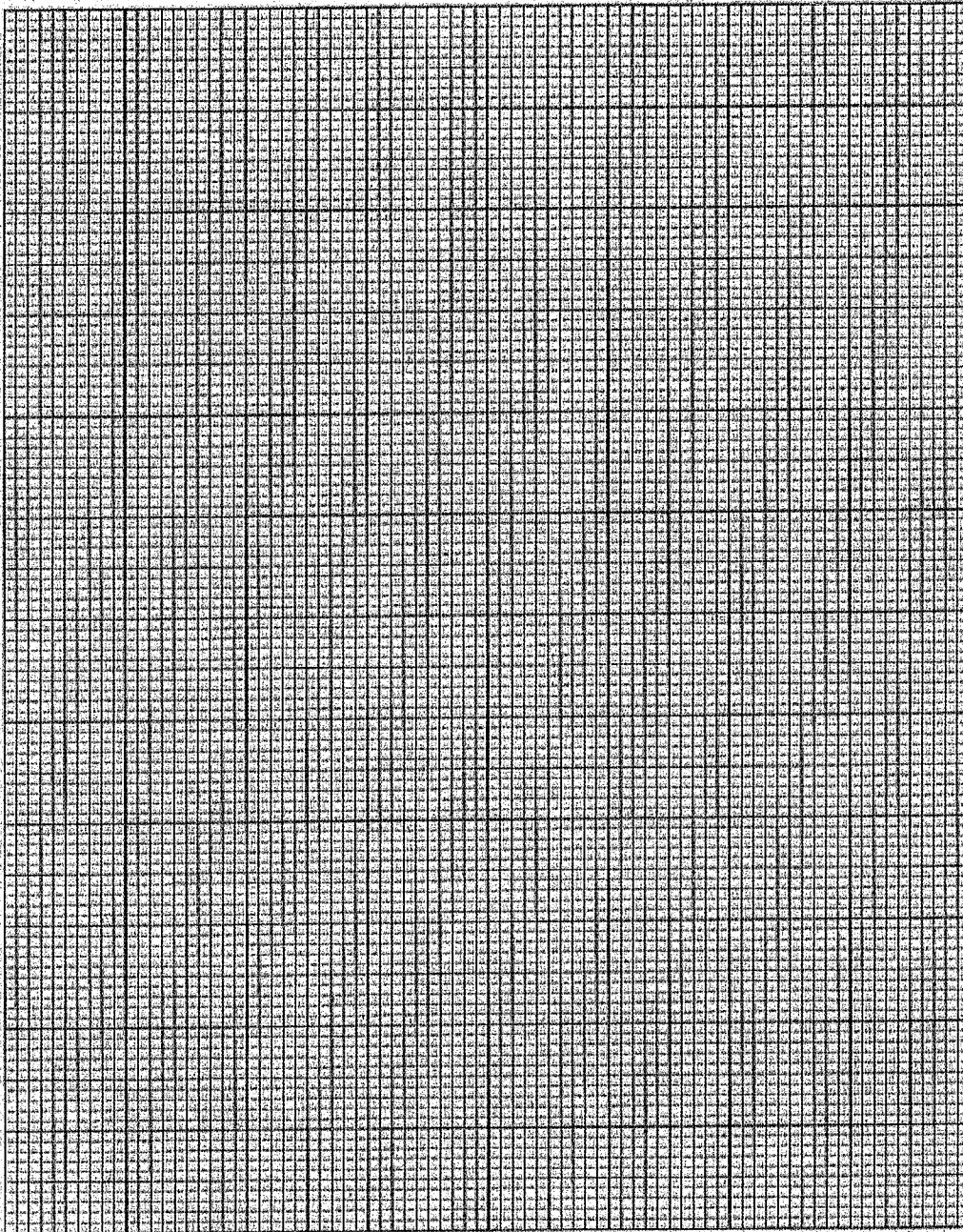
$v = f \lambda$	$\sin \theta = m \lambda / a$
$c = nv$	$n_i \sin \theta_i = n_r \sin \theta_r$



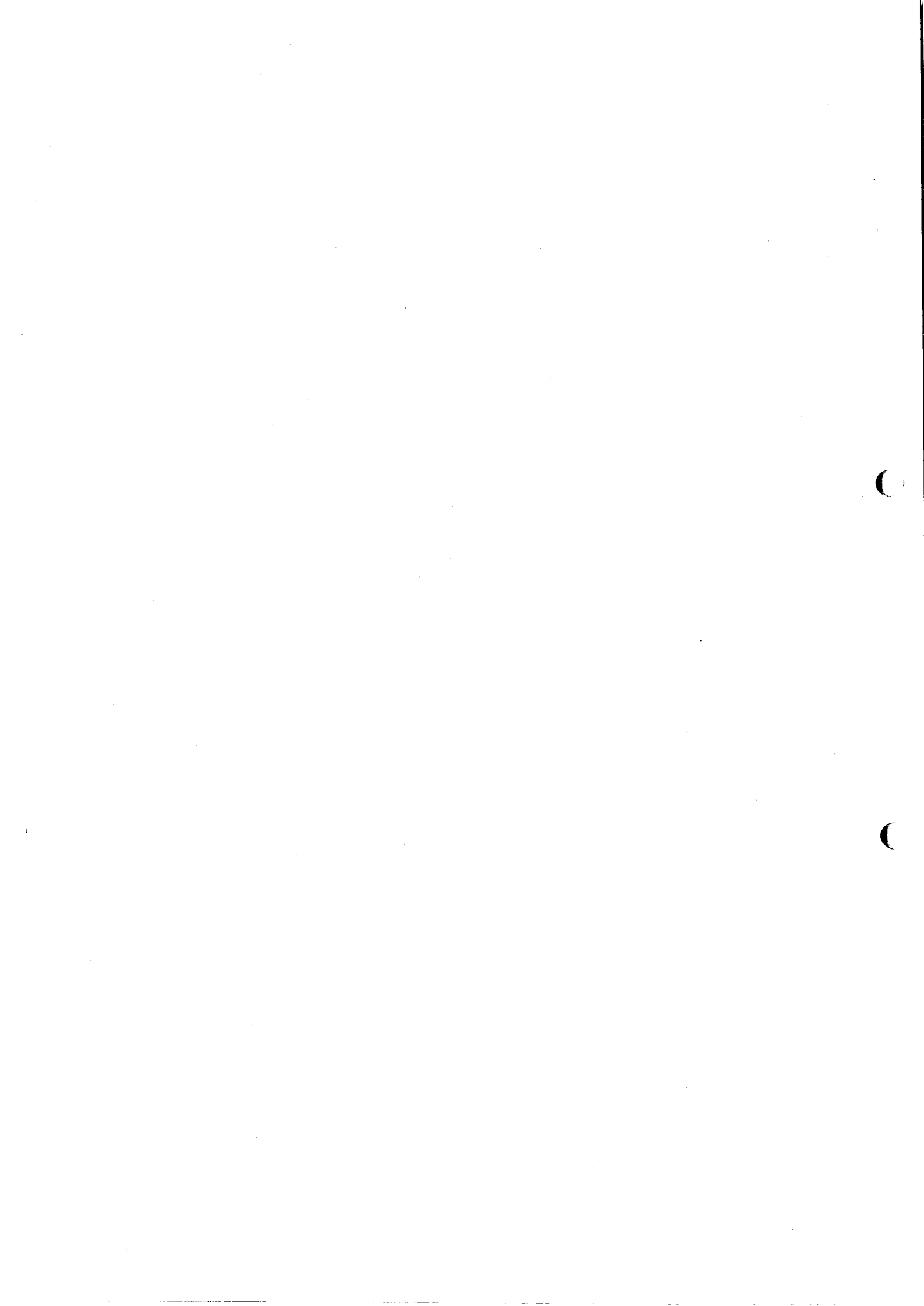
NAME: _____

GRADE: _____

QUESTION 6.2



TEAR-OFF SHEET





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MEMORANDUM

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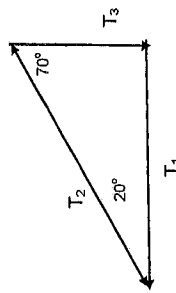
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QUESTION 1

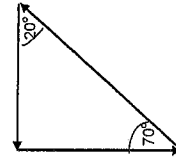
- 1.1 A ✓✓ (2)
 - 1.2 B ✓✓ (2)
 - 1.3 C ✓✓ (2)
 - 1.4 B ✓✓ (2)
 - 1.5 D ✓✓ (2)
 - 1.6 B ✓✓ (2)
- [12]

QUESTION 2

- 2.1 A scalar has magnitude only ✓ whereas a vector has both magnitude and direction. ✓ (2)
- 2.2 Resultant force is zero. ✓
The system is in a state of equilibrium. ✓ (2)
- 2.3



OR



Criteria for marking the diagram	Marks
Correct shape	✓
Correct labels	✓
Two angles placed correctly	✓✓

(4)

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Please turn over

2.4

$$T_3 = 2000\text{N} \checkmark \checkmark$$

$$T_2 \sin 70^\circ = 2000 \checkmark$$

$$T_2 = 2128,36 \text{ N} \checkmark$$

$$T_1 = T_2 \cos 70^\circ$$

$$= 2128,36 \sin 20^\circ \checkmark$$

$$= 727,94 \text{ N} \checkmark$$

OR

$$T_3 = 2000\text{N} \checkmark \checkmark$$

$$T_2 \cos 20^\circ = 2000 \checkmark$$

$$T_2 = 2128,36 \text{ N} \checkmark$$

$$T_1 = T_2 \sin 20^\circ$$

$$= 2128,36 \cos 70^\circ \checkmark$$

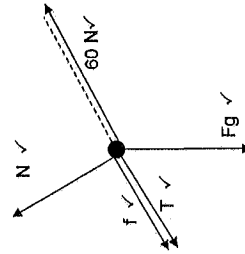
$$= 727,94 \text{ N} \checkmark$$

(6) [14]

QUESTION 3

3.1 When a net force is applied to an object, the object accelerates in the direction of the net force. The acceleration is directly proportional to the (net) force and inversely proportional to the mass of the object. ✓✓

3.2.1



(5)

3.2.2



(2)

3.3 For the 2 kg block

$$-1 + T - mg \sin \theta = 2a \checkmark$$

$$-1 + T - 19,6 \sin 25^\circ = 2a \checkmark$$

$$-T - 9,28 = 2a \checkmark \text{ (1)}$$

For the 3 kg block

$$60 - T - mg \sin \theta - 2 = 3a \checkmark$$

$$60 - T - 14,42 = 3a \checkmark$$

$$45,58 - T = 3a \checkmark$$

(2)

$$36,33 = 5a \checkmark$$

$$7,26 \text{ m.s}^{-2} = a \checkmark$$

(6)

3.4 Using either equation 1 or 2 from question 3.3

$$T - 9,28 = 2a = 2(7,26) \checkmark$$

$$T = 23,80 \text{ N} \checkmark$$

(2)

3.5.1 No effect ✓

(1)

3.5.2 Decreases ✓


(1)

3.5.3 decreases ✓

(1)

3.6 Becomes zero ✓

(1) [21]

- 4.1 When body A exerts a force on body B, body B will exert an equal but opposite force on body A. ✓✓ (2)
- 4.2 Increase. ✓

 The force acting on the girl will be greater than her weight. ✓ From Newton's third law the force on the scale will therefore increase. ✓ (3)
- 4.3 When the lift is in free fall. ✓✓ (2) [7]

QUESTION 5

5.1 Every particle in the universe attracts every other particle with a gravitational force that is directly proportional to the product of their masses and inversely proportional to square of the distance between their centres. ✓✓ (2)

5.2 $F_g = mg$ ✓
 $= 70 \times g$

Also, $F_g = \frac{GM_E \times m}{r^2}$

$= \frac{GM_E \times 70}{r^2}$ ✓

$Mg = 70g = \frac{GM_E \times 70}{r^2}$ ✓

$g = \frac{GM_E}{r^2}$ ✓

(4)

5.3 $g = \frac{6.67 \times 10^{-11} \times 4 \times 5,98 \times 10^{24}}{(6,38 \times 10^3)^2}$ ✓
 $= 39,20 \text{ m.s}^{-2}$ ✓

OR

$g = 4 \times 9,8$ ✓
 $= 39,20 \text{ m.s}^{-2}$ ✓

5.4 Stays the same ✓

(2)

(1)

[9]

QUESTION 6

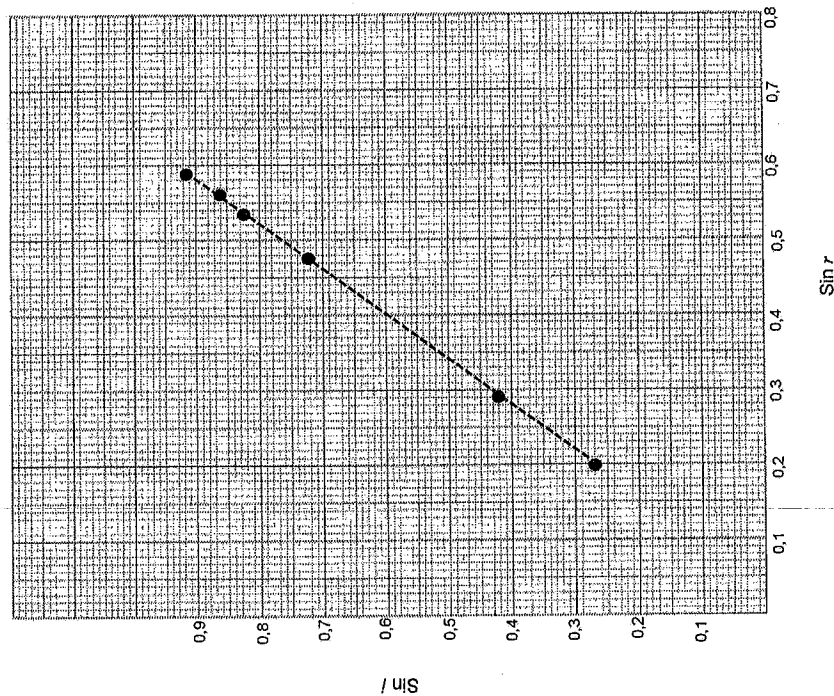
- 6.1.1 Angle of refraction ✓ (1)
- 6.1.2 Angle of incidence ✓ (1)
- 6.1.3 Same glass block ✓ (1)
- 6.2

Angle <i>i</i>	Angle <i>r</i>	Sin <i>i</i>	Sin <i>r</i>
15°	10°	0,26	0,17
25°	16°	0,42	0,28
45°	28°	0,71	0,47
55°	33°	0,82	0,55
60°	35°	0,87	0,57
65°	39°	0,91	0,63

Calculated values correct values = ✓✓

QUESTION 6.2

Graph of $\sin i$ versus $\sin r$



Marking guide for graph

- heading ✓
- labelling of axes ✓
- appropriate scale on both axes ✓
- points plotted correctly ✓✓✓
- line of best fit ✓

NOTE:

- 2 points plotted correctly $\frac{1}{3}$
- 4 points plotted correctly $\frac{2}{3}$
- All points plotted correctly $\frac{3}{3}$

$$n = \frac{\Delta \sin i}{\Delta \sin r} \checkmark$$

$$= \frac{0,91 - 0,26}{0,63 - 0,17}$$

$$= 1,41 \checkmark$$

(Accept any correct calculated gradient)

(11)

6.3 $R = \frac{c}{n} \checkmark$

$$= \frac{3 \times 10^8}{1,41} \checkmark$$

$$= 2,13 \times 10^8 \text{ m.s}^{-1} \checkmark$$

(3)

[17]

QUESTION 7

7.1 Refraction ✓ (1)

7.2 Critical angle ✓ (1)

7.3 Total internal reflection ✓ (1)

7.4 - Light must travel from more dense to less dense medium. ✓ (2)
 - angle of incidence must be greater than critical angle. ✓

7.5 - Use in endoscopes ✓ (1)
 - laser surgery ✓ (any one) [6]

QUESTION 8

- 8.1 Diffraction is the bending of a wave when passing through a small aperture ✓✓ (2)
- 8.2 There would be a bright broad red central band, ✓ flanked on either side by alternate dark and red bands ✓ that are smaller in size. ✓ (3)
- 8.3 When light waves go through the small slit, each point on its wavefront gives rise to secondary wavelets that spread out beyond the barrier. ✓ Most of the waves move through the middle unchanged and interfere constructively on the screen producing the bright broad band. ✓ At the sides of the slit the wavelets spread out in all directions and meet out of phase resulting in destructive interference producing the dark bands. ✓ (3)
- 8.4 - The bands will all be narrower ✓
- more dark bands observed on the screen. ✓ (2)
- 8.5 There would be more diffraction. ✓✓ (2)
- 8.6 Light has a wave nature ✓✓ (2)

[14]**TOTAL MARKS: 100**

