Education

KwaZulu-Natal Department of Education
REPUBLIC OF SOUTH AFRICA

PHYSICAL SCIENCESP1
(PHYSICS)

COMMON TEST

JUNE 2017

NATIONAL
SENIOR CERTIFICATE

GRADE 11

MARKS: 100

TIME : 2 hours

This question paper consists of 9 pages and a 1 page data sheet.

INSTRUCTIONS AND INFORMATION TO CANDIDATES

1.   Write your name on the **ANSWER BOOK**.

2.   This question paper consists of EIGHT questions. Answer ALL the questions in
        the ANSWER BOOK.

3.   Start EACH question on a NEW page in the ANSWER BOOK.

4.   Number the answers correctly according to the numbering system used in this
        question paper.

5.   Leave ONE line between two subsections, for example between
        QUESTION 2.1 and QUESTION 2.2.

6.   You may use a non-programmable calculator.

7.   You may use appropriate mathematical instruments.

8.   You are advised to use the attached DATA SHEET.

9.   Show ALL formulae and substitutions in ALL calculations.

10.   Round off your final numerical answers to a minimum of TWO decimal places.

11.   Give brief motivations, discussions, et cetera where required.

12.   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 – 1.5) in the ANSWER BOOK,
for example 1.6 D.

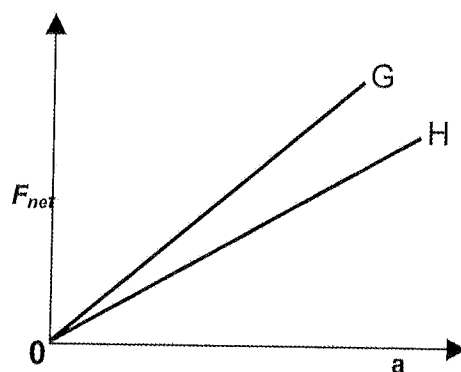1.1   Consider the following vector diagram:
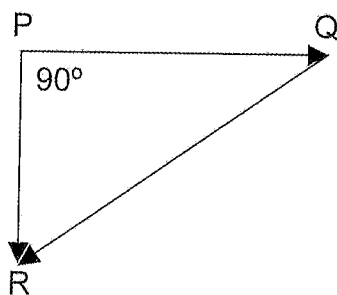
The vector which represents the resultant of the other two, is . . .

A   PQ

B   QR

C   QP

D   PR   (2)

1.2   In an investigation of the relationship between acceleration (**a**) and net force (**F**)
        for two objects (G and H), the following graph was obtained.

Which ONE of the following conclusions can be made from the above graph.

A   The mass of object G is smaller than the mass of object H.

B   The mass of object G is greater than the mass of object H.

C   Both objects, G and H experience the same acceleration.

D   Both objects, G and H have equal masses.   (2)

1.3   Huygens Principle states that …

     A   a wave front bends as it passes through a narrow opening.

     B   the nodal lines are the result of destructive interference of two wave fronts.

     C   every point on a wave front may be considered as a new source of circular wave fronts.

     D   A wave front is an imaginary line that is tangential to wavelet points that are in phase.   (2)

1.4   Which ONE of the following statements is CORRECT?

     A   Optical density is a measure of the refracting power of a medium.

     B   Materials with a high refractive index have a low optical density.

     C   The higher the optical density of a medium, the smaller the amount of refraction as the light moves through the medium.

     D   The lower the optical density, the slower the speed of the light as it moves through the medium.   (2)

1.5   Which ONE of the following is necessary for the observation of diffraction through a slit?

     A   The slit width should be equal to the wavelength of the waves.

     B   The slit width should be less than the wavelength of the waves.

     C   The slit width should be greater than the wavelength of the waves.

     D.   The wavelength of the waves should be less than the distance to the screen.   (2)

[10]

QUESTION 2

An object of mass 158,85 kg is suspended between two walls by means of two cables T_1 and T_2 as shown in the sketch below.
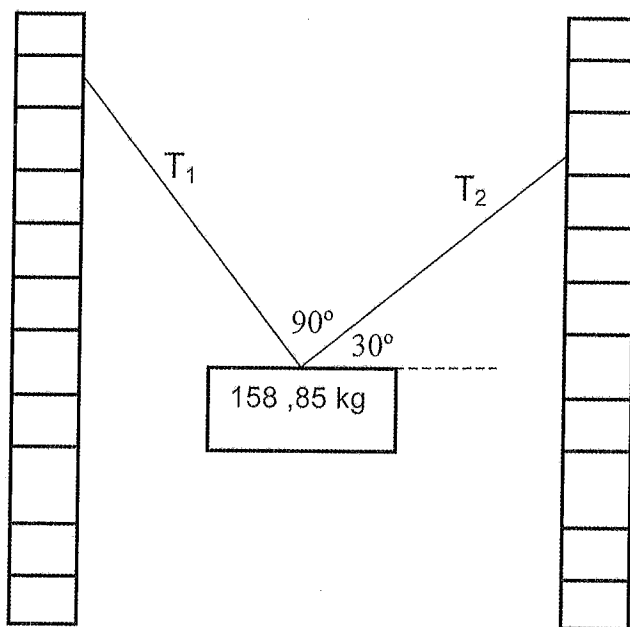
The angle between the cables, T_1 and T_2 is 90°. The angle between cable T_2 and the horizontal is 30°. The net force acting on the object is zero.

2.1   Is mass a scalar or a vector quantity? Give a reason for the answer.   (2)

2.2   Draw a labelled closed vector diagram of forces, showing ALL the forces acting on the object. Also correctly indicate on the diagram TWO angles.   (5)

2.3   Without performing a calculation identify which cable, T_1 or T_2 exerts the larger force on the object. Give a reason for your answer.   (2)

2.4   Determine by means of calculations, the magnitude of

    2.4.1 T_1.   (2)

    2.4.2 T_2.   (2)

                                      [13]

QUESTION 3

An empty lift of mass 450 kg is initially at rest on the ground floor of a building. The cable that supports the lift pulls the lift up to the second floor at a constant speed of 0.6 m.s^{-1}.

3.1   What will be the magnitude of the tension in the cable while the lift moves
      upwards at a constant speed of 0.6 m.s^{-1}?   (2)

Passengers with an unknown total mass climb into the lift. The lift accelerates upwards at 1,25 m.s^{-2}, while the cable that supports the lift exerts a constant upward force of 7 500 N. (Ignore the effects of air resistance).

3.2   State *Newton's Second law of Motion* in words.   (2)

3.3   Draw a labelled force-diagram of ALL the forces acting on the lift while it
      accelerates upwards.   (2)

3.4   Calculate the total unknown mass of the passengers in the lift.   (3)
                                                                                      [9]

QUESTION 4

4.1   State *Newton's Third Law of Motion* in words.   (2)

4.2   Two blocks, of mass 9 kg and 5 kg respectively, are joined with an inelastic
      string of negligible mass. The string runs over a frictionless pulley. The 9 kg
      block is on a rough horizontal surface while the 5 kg block is on a rough
      inclined plane of 25° with the horizontal.

      A force of magnitude 35 N is applied, to the 9 kg block, parallel to the
      horizontal surface, causing the blocks to accelerate at 0,24 m.s^{-2} in the
      direction shown.

      The 9 kg block experiences a 4 N frictional force as it moves to the left.
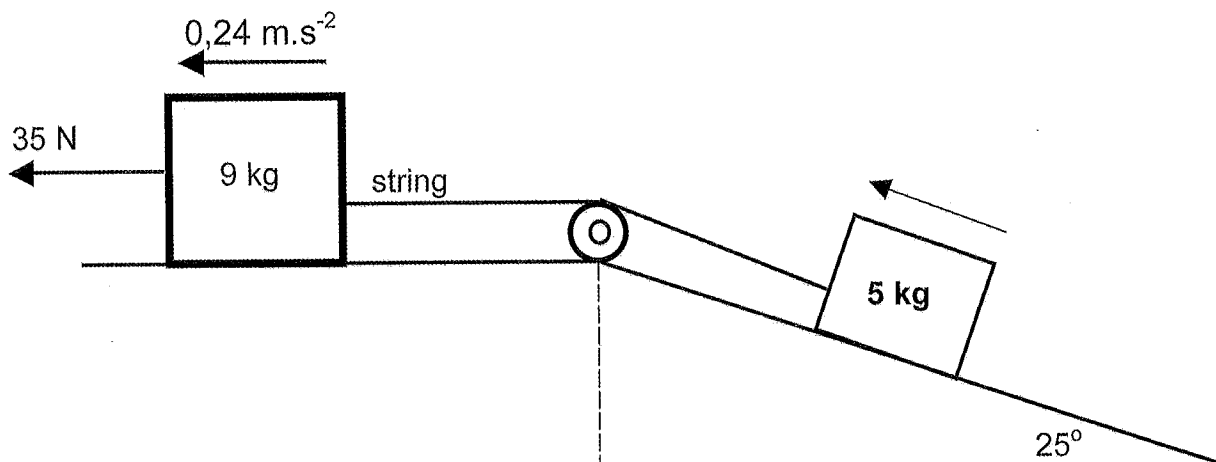
4.2.1   Calculate the tension in the string that joins the TWO blocks together.   (4)

4.2.2   Draw a labelled free body diagram to show ALL the forces that act on
        the 5 kg block.   (4)

4.2.3   Calculate the magnitude of the net force acting on the 5 kg block.   (3)

4.2.4   Calculate the co-efficient of kinetic friction between the 5 kg block
        and the surface.   (6)
                                                                                  [19]

QUESTION 5

5.1   State *Newton's Universal Gravitational Law* in words.   (2)

5.2   An astronaut of mass 80 kg lands on an unknown planet, the radius of which
        is half that of the earth and the mass of which is three times that of earth.

        Calculate the force of attraction exerted on the astronaut by the . . .

        5.2.1   Earth.   (2)

        5.2.2   Unknown planet.   (5)
                                                                                  [9]

QUESTION 6

A group of learners conducted an experiment by passing a ray of light through an
unknown transparent substance and recorded the following data when the ray of
light passed from the transparent substance into air.

Angle of refraction (°)	Angle of incidence (°)
20.00	14,90
30,00	y
55,00	38,00

The refractive index of air is 1.

6.1   According to the data in the table does the light ray refract TOWARDS or AWAY
        from the normal when it exits the unknown transparent material. Give a reason for
        the answer.   (2)

6.2   Name the wave characteristic of the light ray that remains unchanged as the light
        ray moves from the unknown transparent substance into air.   (1)

6.3 Define each of the following:

6.3.1 refractive index. (2)

6.3.2 angle of incidence. (2)

6.4 Calculate the refractive index of the transparent substance. (3)

6.5 Calculate the speed of light in the unknown transparent substance. (3)

6.6 In conducting the experiment, the learners forgot to record the angle of incidence indicated by the letter y in the table.

6.6.1 State *Snell's Law* in words. (2)

6.6.2 Calculate the value of y. (4)
[19]

QUESTION 7

A diamond sparkles because it is cut in such a way that almost all of the light that enters it is totally internally reflected from the sides and is then emitted from the top of the diamond.

7.1 Define the term critical angle. (2)

7.2 List TWO conditions that must be satisfied for total internal reflection to occur. (2)

7.3 How would the size of the critical angle for diamond compare to that of most transparent media? Write down only **bigger than**, **smaller than** or **the same**. (1)
**[5]**

QUESTION 8

During an experiment, a group of learners were given the following investigative question:

"What is the relationship between the degree of diffraction and the width of the slit through which monochromatic light is passed?"

8.1. From the above investigative question name the . . .

8.1.1 dependant variable. (1)

8.1.2 independant variable. (1)

8.2 Name TWO variables that must be kept constant during the above investigation. (2)

8.3 In terms of the investigative question what information should the learners record as they perform the experiment? (2)

8.4 The diagram below, shows the pattern that formed on a screen 2 m, away when learners shone blue light through a narrow slit of width, *a*.
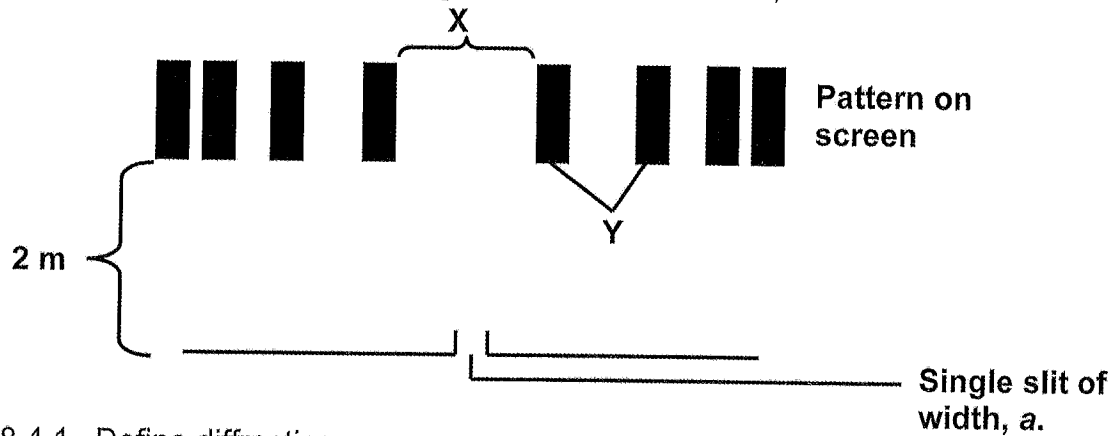
8.4.1 Define diffraction. (2)

8.4.2 Use Huygen's principle to explain the formation of

8.4.2. (a) X (4)

8.4.2. (b) Y (2)

8.4.3 Copy the broad central band X, together with the two dark bands on either side of X in your answer book, and label it M.
Below it sketch the same bands that would be observed if a slit of smaller width was used and label it N. (2)

[16]

TOTAL: 100

DATA FOR PHYSICAL SCIENCES GRADE 11
PAPER 1 (PHYSICS)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 11
VRAESTEL 1 (FISIKA)

TABLE 1: PHYSICAL CONSTANTS/TABEL 1: FISIESE KONSTANTES

NAME/NAAM	SYMBOL/SIMBOOL	VALUE/WAARDE
Acceleration due to gravity Swaartekragversnelling	g	$9,8 \ \text{m·s}^{-2}$
Gravitational constant Swaartekragkonstante	G	$6,67 \times 10^{-11} \ \text{N·m}^2\text{·kg}^{-2}$
Radius of Earth Straal van Aarde	R_E	$6,38 \times 10^6 \ \text{m}$
Speed of light in a vacuum Spoed van lig in 'n vakuum	c	$3,0 \times 10^8 \ \text{m·s}^{-1}$
Mass of the earth Massa van die Aarde	M	$5,98 \times 10^{24} \ \text{kg}$

TABLE 2: FORMULAE/TABEL 2: FORMULES

MOTION/BEWEGING

$v_f = v_i + a\,\Delta t$	$\Delta x = v_i \Delta t + \frac{1}{2}a\Delta t^2$
$v_f^{\,2} = v_i^{\,2} + 2a\Delta x$	$\Delta x = \left(\dfrac{v_f + v_i}{2}\right)\Delta t$

FORCE / KRAG

$F_{net} = ma$	$w = mg$
$F = \dfrac{Gm_1 m_2}{r^2}$	$\mu_s = \dfrac{f_{s(max)}}{N}$
$\mu_k = \dfrac{f_k}{N}$	

WAVES, SOUND AND LIGHT/GOLWE, KLANK EN LIG

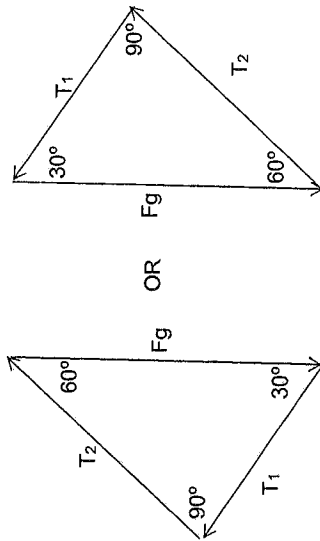|	
$v = f\lambda$	$T = \dfrac{1}{f}$
$n_i \sin\theta_i = n_r \sin\theta_r$	$n = \dfrac{c}{v}$

QUESTION 1

1.1   D ✓✓
1.2   B ✓✓
1.3   C ✓✓
1.4   A ✓✓
1.5   C ✓✓

5 x 2 = [10]

QUESTION 2

2.1   scalar ✓
     has magnitude only ✓ or has no direction ✓   (2)

2.2

Fg label and arrow	✓
T₁ label and arrow	✓
T₂ label and arrow	✓
Any two correct angles	✓✓

(5)

2.3   *Positive marking from the diagram.*
    T_1 ✓
    T_1 is the side opposite the larger angle. ✓   (2)

2.4.1 T_1 = Fgsin60° ⎫
       = mgsin60° ⎬ any one ✓
       = (158,85)(9,8)sin60° ⎭
       = 1348,17 N ✓

       T_1 = Fgcos30° ⎫
           = mgcos30° ⎬ any one ✓
           = (158,85)(9,8)cos30° ⎭
           = 1348,17 N ✓   (2)

2.4.2 T_2 = Fgsin30° ⎫
       = mgsin30° ⎬ any one ✓
       = (158,85)(9,8)sin30° ⎭
       = 778,37 N ✓

       T_1 = Fgcos60° ⎫
           = mgcos60° ⎬ any one ✓
           = (158,85)(9,8)cos60° ⎭
           = 778,37 N ✓   (2)

[13]

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PHYSICAL SCIENCES P1
(PHYSICS)

MARKING GUIDELINE

COMMON TEST

JUNE 2017

**NATIONAL
SENIOR CERTIFICATE**

GRADE 11

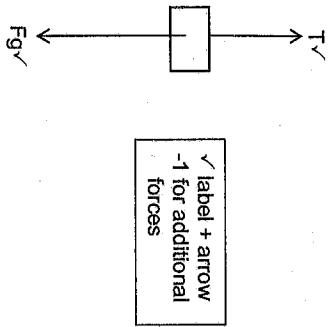N.B.   This marking guideline consists of 6 pages.

QUESTION 3

3.1 $T + (-Fg) = ma = 0$ } any one ✓
  $T = mg$
  $T = (450)(9,8)$
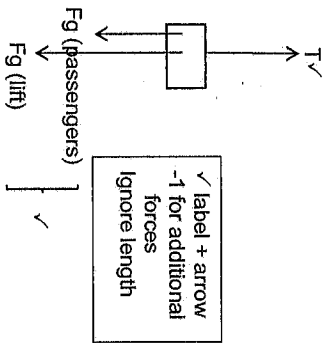 $T = 4410 \text{ N}$ ✓ (2)

3.2 When a resultant/net force acts on an object, the object will accelerate in the direction of this force at an acceleration directly proportional to the net force✓ and inversely proportional to the mass of the object.✓ (2)

3.3

✓ label + arrow
-1 for additional forces (2)

3.3

✓ label + arrow
-1 for additional forces
Ignore length (2)

3.4 $T + (-Fg) = ma$ } any one ✓
  $T - Fg = ma$
  $T = m(a + g)$
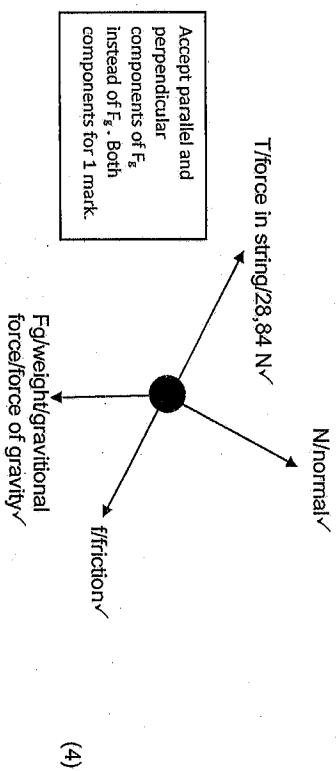 $= m(1,25 + 9,8)$✓
  $m = 678,73 \text{ kg}$✓ (3)
  [9]

QUESTION 4

4.1 When object A exerts a force on object B, object B simultaneously exerts✓ an oppositely directed force of equal magnitude on object A. ✓ (2)

4.2.1

		F_{net}	$=$	ma	
35	$+$	$(-T)$	$+$	$(-f)$	$=$	ma	} any one✓
35	$-$	T	$-$	4 ✓	$=$	$(9)(0,24)$ ✓
				T	$=$	$28,84 \text{ N}$✓

(4)

4.2.2

Fg/weight/gravitational force/force of gravity✓
N/normal✓
T/force in string/28,84 N✓
f/friction✓

(4)

4.2.3 F_{net} $=$ ma✓
  $=$ $(5)(0,24)$ ✓
  $=$ $1,20 \text{ N}$✓ (3)

Accept parallel and perpendicular components of F_g instead of F_g. Both components for 1 mark.

4.2.4

			F_{net}	$=$	ma	
T	$+$	$(-f)$	$+$	$(-Fgp)$	$=$	ma	} any one✓
T	$-$	f	$-$	$mgsin\theta$	$=$	ma
$28,84$	$-$	f	$-$	$(5)(9,8)sin25°$✓	$=$	$(5)(9,8)sin25°$✓

  $f = 6,93 \text{ N}$

  $f_k = \mu_k N$
  $\mu_k = \mu_k mgcos\theta$✓
  $6,93 = \mu_k (5)(9,8)cos25°$✓
  $\mu_k = \dfrac{6,93}{(5)(9,8)cos25°}$✓
  $\mu_k = 0,16 \text{ or } 0,156$ ✓ (6)
  [19]

QUESTION 5

5.1 Each 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 the square of the distance between their centres. ✓ (2)

5.2.1 $Fg = mg$✓
  $= (80)(9,8)$
  $= 784 \text{ N}$✓ (2)

5.2.2

$$F = \frac{Gm_1m_2}{r^2} \checkmark$$

$$= \frac{(G)(m_1)(3m_2)}{\left(\frac{r}{2}\right)^2} \checkmark$$
$$\checkmark$$

F_{new} = 12 x 784   ✓ for multiplying by 784

= 9 408 N ✓

(5)
[9]

QUESTION 6

6.1 away✓
The angle of refraction is larger than the corresponding angle of incidence✓ (2)

6.2 frequency✓ (1)

6.3.1 The ratio of the speed of light in a vacuum ✓ to the speed of light in a material. ✓ (2)

6.3.2 The angle between the normal to a surface and the incident light ray. ✓✓ (2 or 0)

6.4
$$n_i\sin\theta_i = n_r\sin\theta_r \checkmark$$
$$n_i\sin14{,}90° = (1)(\sin20°) \checkmark$$
$$n_i = 1{,}33 \checkmark$$

$$\frac{n_i\sin\theta_i}{n_i\sin38°} = \frac{n_r\sin\theta_r}{(1)(\sin55°)} \checkmark$$
$$n_i = 1{,}33 \checkmark$$
(3)

6.5
$$n = \frac{c}{v} \checkmark$$
$$1{,}33 = \frac{3\times10^8}{v} \checkmark$$
$$v = 2{,}26 \times 10^8 \text{ m.s}^{-1}\checkmark$$
(4)

6.6.1 The ratio of the sine of the angle of incidence in one medium to the sine of the angle of refraction in the other medium is a constant. ✓✓ (2)

6.6.2
$$n_i\sin\theta_i = n_r\sin\theta_r \checkmark$$
$$1{,}33\sin y° \checkmark = (1)(\sin30°) \checkmark$$
$$y = 22{,}08 \checkmark$$
(4)
[19]

QUESTION 7

7.1 The angle of incidence in the optically denser medium✓ for which the angle of refraction in the optically less dense medium is 90°. ✓ (2)

OR

The angle of incidence for which the angle of refraction is 90° when light passes from an optically dense to an optically less dense medium.

7.2 light must travel from an optically denser medium (higher refractive index) to an optically less dense medium (lower refractive index). ✓ the angle of incidence in the optically denser medium must be greater than the critical angle. ✓ (2)

7.3 smaller than✓ (1)
[5]

QUESTION 8

8.1.1 degree of diffraction. ✓ (1)
8.1.2 width of slit. ✓ (1)

8.2 wavelength(frequency) of light✓
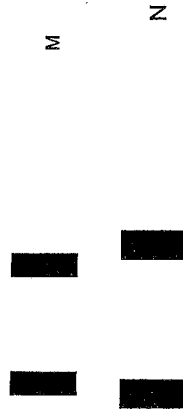distance of the slit from the screen✓ (2)

8.3 width of the slit✓
width of the broad bright central band✓ (2)

8.4.1 the ability of a wave to spread out in wave fronts as the wave passes through a small aperture or around a sharp edge. ✓✓ (2)

8.4.2(a) When the waves pass through the single slit every point on the wavefront gives rise to secondary wavelets. ✓ when waves meet in phase ✓ they produce constructive interference ✓ which results in a bright band. ✓ (4)

8.4.2(b) Waves meet out of phase producing destructive interference ✓ resulting in a dark band. ✓ (2)

8.4.3   M   N

broader central band✓✓ (2)
[16]