education

Department:
Education
PROVINCE OF KWAZULU-NATAL

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

COMMON TEST

JUNE 2018

MARKS: 100

TIME : 2 hours

This question paper consists of 9 pages and 2 data sheets.

INSTRUCTIONS AND INFORMATION TO CANDIDATES

1. Write your name on the **ANSWER BOOK**.
2. This question paper consists of SEVEN 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.

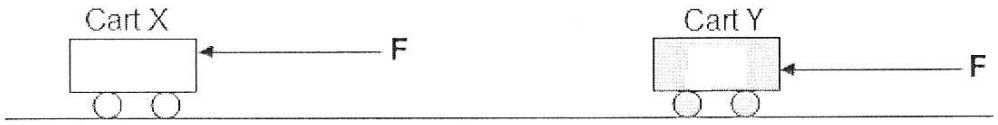
QUESTION 1: MULTIPLE- CHOICE QUESTIONS

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 – 1.7) in the ANSWER BOOK, for example 1.4 D.

1.1 A spaceship experiences a weight of X on earth. It is sent into space and lands on a planet which has a mass twice that of the earth and a radius ½ that of the earth. The weight of the spaceship will be ...

A 8X
B ½X
C X
D ¼X (2)

1.2 Two Carts, X and Y, move along a frictionless horizontal track with the same momentum. Cart X has TWICE the mass of Cart Y.



When the horizontal retarding force F is applied simultaneously to both carts, Cart X stops in a time of **t** seconds.

The time taken for Cart Y to stop will be...

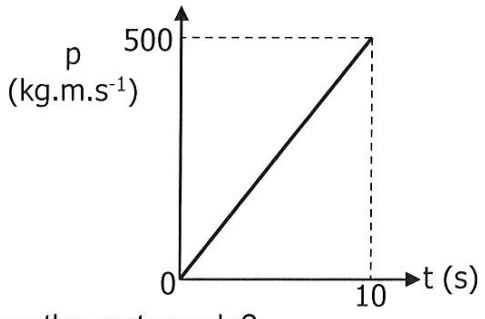
A ½t
B t
C 2t
D 4t (2)

1.3 An object, moving vertically upwards, reaches a maximum height and falls back to the ground. Ignore air resistance. Which ONE of the following statements is TRUE?

The object experiences an acceleration which ....

A is first downwards and then upwards
B is first upwards and then downwards
C is always downwards
D decreases first and then increases (2)

1.4 The graph shows how the momentum of a motorcycle changes with time.



What is the resultant force on the motorcycle?

A 50 N
B 500 N
C 2500 N
D 5000 N

(2)

1.5 A girl is lifting boxes of identical mass from the ground onto a bench. At first, it takes her **2 s** to lift each box. Later in the day it takes her **3 s**. Which of the following statements will now be true when she lifts the boxes later in the day?

A Less work is done in lifting each box.
B More work is done in lifting each box.
C Less power is required to lift each box.
D Greater power is required to lift each box (2)

1.6 A girl stands next to the road as a fire engine approaches her with its sirens blaring and the red flashlights on.
Which is the correct observation that the girl makes?

	Frequency of sound heard	**Colour of flashlight**
A	Lower	Red
B	Higher	Red
C	Lower	Orange
D	Higher	Orange

(2)

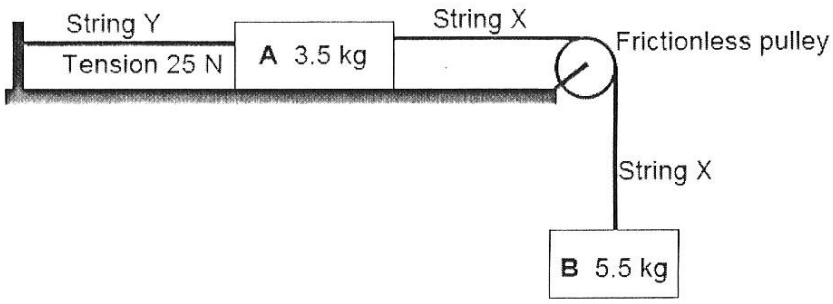
1.7 Light reaching the Earth from a galaxy moving away is shifted towards…

A shorter wavelengths
B greater velocities
C higher frequencies
D longer wavelengths (2)

[14]

QUESTION 2

Block A (mass 3.5 kg) and Block B (mass 5.5 kg) are connected via a light, inextensible string, **X**, over a frictionless pulley. Block A is attached to a fixed point by string Y, and is placed on a rough horizontal surface.



2.1 State *Newton's First Law* of motion in words. (2)

2.2 Calculate the magnitude of the tension in string **X**. (2)

2.3 Draw a labelled force diagram to represent the HORIZONTAL forces acting on Block **A**. (3)

2.4 Calculate the magnitude of the frictional force acting between block **A** and the surface. (3)

String **Y** is cut and the system starts accelerating. The tension in string **X** is now 34.17 N.

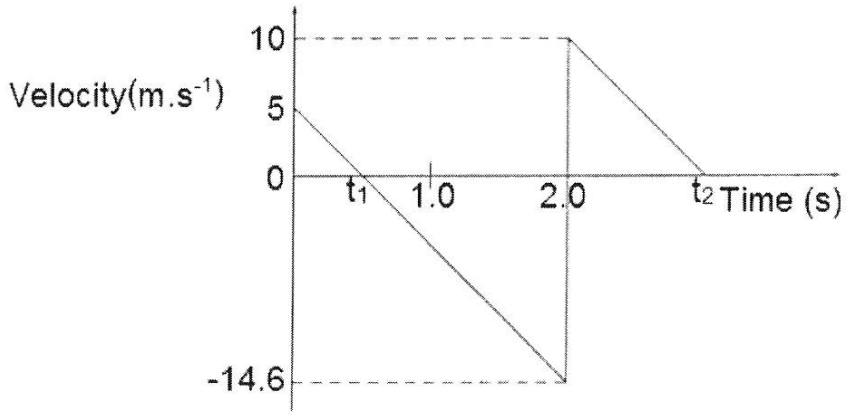
2.5 State Newton's Second Law of motion in words. (2)

2.6 Calculate the magnitude of the acceleration of the system. (4)
[16]

QUESTION 3

A ball is thrown vertically upwards by a boy standing on top of a building. The ball hits the ground below and bounces vertically upwards.

The graph below shows the motion of the ball.



Neglect any effects of air friction.

3.1 Define a *projectile*. (2)

3.2 What does t_1, indicated on the graph, represent? (1)

3.3 Determine the value of t_1. (3)

3.4 Calculate the height of the building. (4)

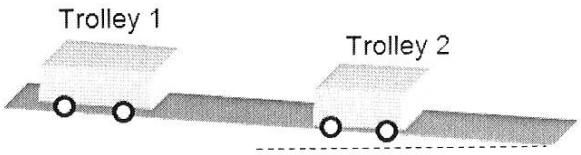
3.5 Calculate the value of t_2. (3)

3.6 USE THE GRAPH (i.e. do not use equations of motion) to calculate the distance between the initial position of the ball (i.e. when it leaves the boy's hand) and its maximum height after bouncing. (3)

[16]

QUESTION 4

Two boys set up an experiment where they gently push trolley 1 down a gentle slope, and it then collides with a stationary trolley 2.

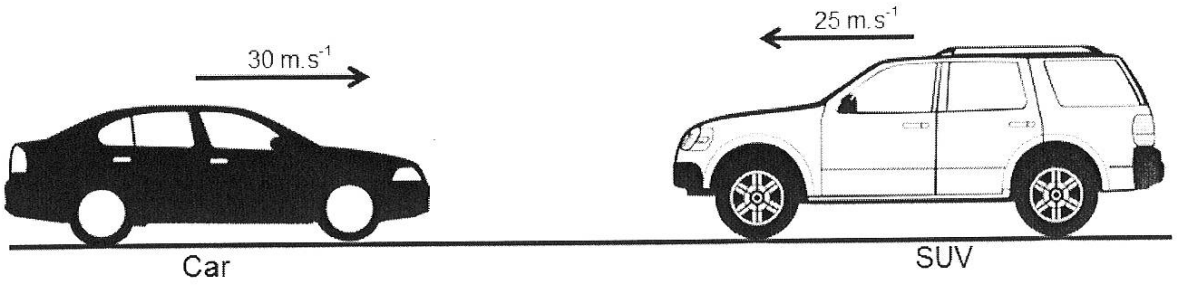


They want to work out the momentum of the trolleys before and after the collision

4.1 Give a reasonable hypothesis for this experiment. (2)

4.2 State the definition of *momentum*. (2)

A small car of mass 1 084 kg was travelling east at a speed of 30 $m \cdot s^{-1}$. A large SUV of mass 3 437 kg was travelling west at a speed of 25 $m \cdot s^{-1}$. The two vehicles collided head on with each other.



Immediately after the collision, the small car was moving west at 5 $m \cdot s^{-1}$.

4.3 NAME the law that can be used to calculate the velocity of the SUV immediately after the collision. (1)

4.4 Determine the velocity of the SUV immediately after the collision. (5)

4.5 Explain what is meant by an *inelastic collision*. (2)

4.6 Use calculations to determine if the collision was elastic or not. (6)

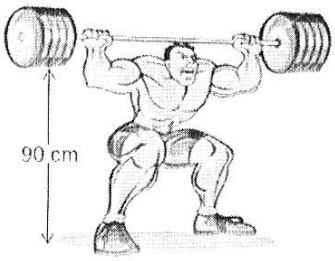
4.7 Both drivers are wearing seat belts. Which driver is likely to be more severely injured on impact? Explain the answer by referring to acceleration and velocity. (3)

[21]

QUESTION 5

A weightlifter raises a pack of weights of mass 160 kg through a height of 90 cm. To do this, he exerts a force of 2800 N on the weights.

The effects of air resistance may be ignored.



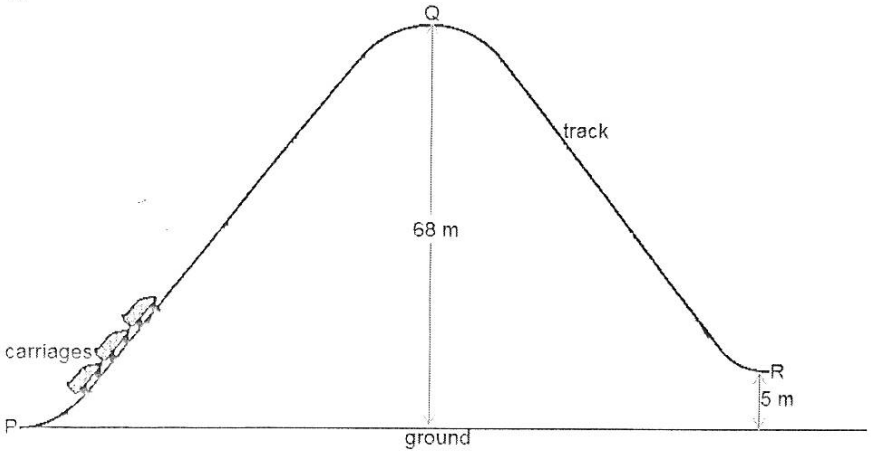
5.1 Draw a labelled free body diagram showing all forces acting on the weights when they are held 90 cm above the ground. (2)

5.2 Calculate the net work done by the weightlifter on the weights. (4)
[6]

QUESTION 6

The diagram shows part of the roller-coaster at the amusement park. The carriages are pulled from **P** to **Q** at a steady speed by an electric motor with a power output of 48 kW. Points **Q** and **R** are 68 m and 5 m, respectively, above the ground. At **Q** the carriages have effectively no kinetic energy and they run freely down to **R**. The total mass of the carriages is 3 600 kg.

Ignore the effects of air friction.



6.1 Determine the total mechanical energy of the carriages at point **Q**. (3)

6.2 State the definition of *power*. (2)

6.3 Calculate the time taken for the carriages to move from **P** to **Q**. (3)

6.4 State the principle of conservation of mechanical energy in words. (2)

6.5 Calculate the speed of the carriages on reaching point **R**. (4)
[14]

QUESTION 7

A stationary source emits a sound wave of frequency 5000 Hz. An object approaches to this source with an unknown velocity. The sound wave is reflected from the moving object, which is then detected by the source.

Take the speed of sound in air as 340 $m.s^{-1}$.

7.1 State the definition of the *Doppler Effect*. (2)

7.2 Calculate the wavelength of the waves being generated by the source. (3)

7.3 Calculate the velocity of the object if the detected wave, by the source, has a frequency of 5104 Hz. (6)

7.4 State TWO applications of the Doppler Effect in Medical Science. (2)

[13]

TOTAL: 100

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
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 $m \cdot s^{-2}$
Universal gravitational constant *Universele gravitasiekonstante*	G	$6,67 \times 10^{-11}$ $N \cdot m^2 \cdot kg^{-2}$
Speed of light in a vacuum *Spoed van lig in 'n vacuum*	c	$3,0 \times 10^8$ $m \cdot s^{-1}$
Planck's constant *Planck se konstante*	h	$6,63 \times 10^{-34}$ $J \cdot s$
Coulomb's constant *Coulomb se konstante*	k	$9,0 \times 10^9$ $N \cdot m^2 \cdot C^{-2}$
Charge on electron *Lading op electron*	e	$-1,6 \times 10^{-19}$ C
Electron mass *Elektronmassa*	m_e	$9,11 \times 10^{-31}$ kg
Mass of Earth *Massa van Aarde*	M	$5,98 \times 10^{24}$ kg
Radius of Earth *Radius van Aarde*	R_E	$6,38 \times 10^6$ m

TABLE 2: FORMULAE / TABEL 2: FORMULES

MOTION / BEWEGING

$v_f = v_i + a\Delta t$	$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$ or/of $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$v_f^{\ 2} = v_i^{\ 2} + 2a\Delta x$ or/of $v_f^{\ 2} = v_i^{\ 2} + 2a\Delta y$	$\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ or/of $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$

FORCE / KRAG

$F_{net} = ma$	$p = mv$
$f_{s(max)} = \mu_s N$	$f_k = \mu_k N$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = \frac{Gm_1 m_2}{r^2}$	$g = \frac{Gm}{r^2}$

WORK, ENERGY AND POWER / ARBEID, ENERGIE EN DRYWING

$W = F\Delta x\cos\theta$	$U = mgh$ or/of $E_P = mgh$
$K = \frac{1}{2}mv^2$ or/of $E_k = \frac{1}{2}mv^2$	$W_{net} = \Delta K$ or/of $W_{net} = \Delta E_k$ $\Delta K = K_f - K_i$ or/of $\Delta E_k = E_{kf} - E_{ki}$
$W_{nc} = \Delta K + \Delta U$ or/of $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{av} = F \cdot v_{av}$ / $P_{gem} = F \cdot v_{gem}$	

WAVES, SOUND AND LIGHT / GOLWE, KLANK EN LIG

$v = f\lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$	$E = hf$ or/of $E = h\frac{c}{\lambda}$
$E = W_o + E_{k(max)}$ or/of $E = W_o + K_{(max)}$ where/waar $E = hf$ and/en $W_o = hf_o$ and/en $E_{k(max)} = \frac{1}{2}mv_{max}^2$ or/of $K_{(max)} = \frac{1}{2}mv_{max}^2$	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PROVINCE OF KWAZULU-NATAL

PHYSICAL SCIENCES P1

MARKING GUIDELINE

COMMON TEST

JUNE 2018

NATIONAL SENIOR CERTIFICATE

GRADE 12

This marking guideline consists of 6 pages.

QUESTION 1

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

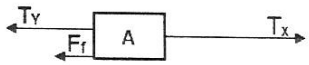
7x 2 = **[14]**

QUESTION 2

2.1 An object continues in a state of rest or uniform velocity unless it is acted upon by a net or resultant force. ✓✓ (2)

2.2 $T_x = mg$
$= (5.5)(9.8)$ ✓
$= 53.90$ N✓ (2)

2.3



Accepted Labels

T_X: Tension X ✓
T_Y : Tension Y ✓
F_f / fs^{max}: Friction ✓

(3)

2.4 **POSITIVE MARKING FROM QUESTION 2.3**

$T_y + T_X + F_f = 0$ ✓
$-25 + 53.9 + F_f = 0$ ✓
$F_f = -28{,}90$
$F_f = 28{,}90$ N ✓ (3)

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

OR

The resultant/net force acting on an object is equal to the rate of change of momentum of the object in the direction of the resultant/net force. ✓✓

2.6 $F_{net} = ma$ ✓
$mg + (-T_x) = ma$
$(5.5)(9.8)$ ✓ $- 34.17$✓ $= 5.5a$
$a = 3.59\ m.s^{-2}$✓ (4)
[16]

QUESTION 3

3.1 An object upon which the only force acting is the force of gravity. ✓✓ (2)

3.2 Time taken by the ball to reach the maximum height. ✓ (1)

3.3

Upward is positive	**Downward is positive**
$v_f = v_i + a\,\Delta t$ ✓	$v_f = v_i + a\,\Delta t$ ✓
$0 = 5 + (-9.8)\,\Delta t$✓	$0 = -5 + 9.8\Delta t$✓
$t_1 = 0.51$ s ✓	$t_1 = 0.51$ s✓

(3)

3.4 **OPTION 1**

Upward is positive	**Downward is positive**
$v_f^2 = v_i^2 + 2a\Delta y$ ✓	$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$(-14.6)^2$ ✓$= 5^2 + 2(-9.8)\,\Delta y$ ✓	$(14.6)^2$✓ $= (-5)^2 + 2(9.8)\,\Delta y$ ✓
$\Delta y = -9.6$	$\Delta y = 9.6$ m
height = 9.6 m ✓	height = 9.6 m ✓

(4)

OPTION 2 POSITIVE MARKING FROM QUESTION 3.3

Δy = area of triangle 1 + area of triangle 2 ✓
$= (½)(0.51)(5)$ ✓$+ (½)(2-0.51))(-14.6)$ ✓
$= -9.60$
height = 9.60 m ✓ (4)

OPTION 3

Δy = area of a trapezium
$= ½$(sum of parallel sides)X(perpendicular distance) ✓
$= ½(-5-14.6)$ ✓X $(2-1.02)$ ✓
$= -9.60$
height = 9.60 m ✓ (4)

3.5 **OPTION 1**

Upward is positive	**Downward is positive**
$v_f = v_i + a\,\Delta t$ ✓	$v_f = v_i + a\,\Delta t$ ✓
$0 = 10 + (-9.8)\,\Delta t$ ✓	$0 = -10 + (9.8)\,\Delta t$ ✓
$\Delta t = 1.02$ s ✓	$\Delta t = 1.02$ s ✓

(3)

OPTION 2

$$\text{slope} = \frac{\Delta v}{\Delta t}$$
$$-9.8 = \frac{0-10}{\Delta t}$$
$$\Delta t = 1.02\ s$$ (3)

3.6 **OPTION 1**

distance = area of triangle 1 + area of triangle 2 + area of triangle 3
$= ½(0.51)(5) + ½(2-0.51)(-14.6)$ ✓ $+ ½(2+1.02)(10)$ ✓
$= -4.50$
distance = 4.50 m ✓ (4)

OPTION 2

distance = area of a trapezium + area of triangle
$= ½(-5-14.6)$ X $(2-1.02)$ ✓ $+ ½(1.02)(10)$ ✓
$= -9.604 + 5.10$
$= -4.504$
distance = 4.50 m ✓ (3)
[16]

QUESTION 4

4.1 Total momentum of the trolleys before collision will equal total momentum after collision because momentum should be conserved in an isolated system. ✓✓ (2)

4.2 The product of mass and velocity of on object. ✓✓ (2)

4.3 Law of conservation of (linear) momentum. ✓ (1)

4.4
total p_{before} = total p_{after} ✓
$(1084)(30) + (3437)(-25)$ ✓$= (1084)(-5) + 3437v_f$ ✓
$v_f = -13{,}96$
$v_f = 13{,}96\ m.s^{-1}$ ✓ (west) ✓ (5)

4.5
total $K_{before} = ½m_1v_{i1}^2 + ½m_2v_{i2}^2$ ✓
$= ½(1084)(30)^2 + ½(3437)(-25)^2$ ✓
$= 1.56 \times 10^6$ J ✓

total $K_{after} = ½m_1v_{f1}^2 + ½m_2v_{f2}^2$
$= ½(1084)(-5)^2 + ½(3437)(-13{,}96)^2$ ✓
$= 3.48 \times 10^5$ J ✓

Inelastic collision ✓ (6)

4.6 Small car driver ✓
(small car-driver system) has greater acceleration ✓
(small car-driver system) has greater change in velocity✓ (3)
[21]

QUESTION 5

5.1

Accepted Labels

$F_{applied}$: Applied force ✓
F_g : weight ✓

(2)

5.2 $W_{net} = F_{net}\Delta x\cos\Theta$ ✓
$= F_{applied}\Delta x\cos\Theta + F_g\Delta x\cos\Theta$
$= (2800)(0.9)\cos0$✓ $+ (160)(9.8)(0.9)\cos180$✓
$= 1108.80$ J ✓ (4)
[6]

QUESTION 6

6.1 $E_M = K + U$
$= \frac{1}{2}mv^2 + mgh$ ✓
$= 0 + (3600)(9.8)(68)$ ✓
$= 2.40 \times 10^6$ J ✓ (3)

6.2 Power is the rate at which work is done or energy is expended. ✓✓ (2)

6.3 $P = \frac{W}{\Delta t}$ ✓
$48000 = 2399040 \div \Delta t$ ✓
$\Delta t = 49.98$ s ✓ (3)

6.4 $(K + U)_Q = (K + U)_R$ ✓
$0 + 2399040$ ✓ $= \frac{1}{2}(3600)v^2 + (3600)(9.8)(5)$ ✓
$v = 35.14$ m.s^{-1}✓ (4)
[12]

QUESTION 7

7.1 Apparent change in frequency (or pitch) of the sound detected by a listener because the sound source and the listener have different velocities relative to the medium of sound propagation. ✓✓ (2)

OR

Apparent change in the observed frequency of a sound wave when the source of the sound is moving relative to the listener.✓✓ (2)

7.2 $v = f\lambda$ ✓
$340 = 5000\lambda$ ✓
$\lambda = 0.068$ m ✓ (3)

7.3 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓

Shift 1: $f_L = \frac{340+vo}{340}(5000)$

Shift 2 : $f_L = \frac{340}{340-vo} f_S$

5104✓ $= \left(\frac{340}{340-vo}\right)$✓ $\times \frac{340+vo}{340}(5000)$ ✓

$v_O = 3.50$ m.s^{-1}✓, towards the source✓ (6)

7.4 To measure heartbeat of the unborn foetus in the womb. ✓
To measure blood flow rate. ✓ (2)
[13]
TOTAL: 100