education

Department:
Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATION - 2007

PHYSICAL SCIENCE P1

HIGHER GRADE

FEBRUARY/MARCH 2007

304-1/1

PHYSICAL SCIENCE HG: Paper 1

MARKS: 200

2 hours

304 1 1E HG

This question paper consists of 17 pages and a data sheet consisting of 2 pages.

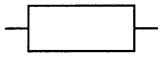
X05

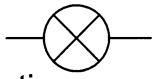
GAUTENG

Please turn over

GENERAL INSTRUCTIONS

1. Write your examination number (and centre number if applicable) in the appropriate spaces on the answer book.
2. Answer ALL the questions.
3. Non-programmable calculators may be used.
4. Appropriate mathematical instruments may be used.
5. A data sheet is attached for your use.
6. NOTE! The following circuit diagram symbols are used in this paper:

Resistor:  instead of 

Bulb:  instead of 

7. Marks may be forfeited if instructions are not followed.

QUESTION 1

INSTRUCTIONS

1. Answer this question on the answer sheet on the inside cover of your answer book.

2. Four possible answers, indicated by A, B, C and D, are supplied with each question. Each question has only ONE correct answer. Choose only that answer which, in your opinion, is the correct or best one and mark the appropriate block on the ANSWER SHEET with a cross (X).

3. Do not make any other marks on the answer sheet. Any calculations or writing that may be necessary when answering this question should be done in the answer book and must be deleted clearly by means of a diagonal line drawn across the page.

4. If more than one block is marked, no marks will be awarded for that answer.

EXAMPLE
QUESTION: The SI unit of time is ...

A t.
B h.
C s.
D m.

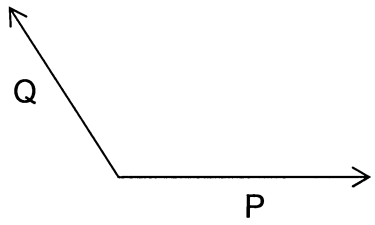
ANSWER:

A	B	C	D

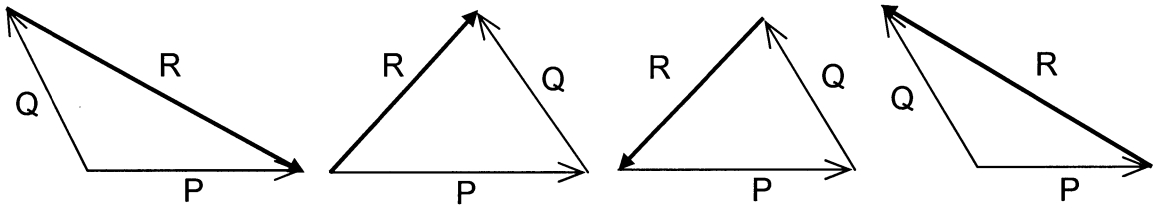
[NOTE: This layout may vary, depending on the type of answer sheet used by the province.]

QUESTION 1

1.1 P and Q are two forces acting simultaneously on an object in different directions producing a resultant force R.



Which ONE of the following diagrams correctly represents the three forces?



A B C D (4)

1.2 A charged particle is placed in an electric field. Which ONE of the following physical quantities, related to the particle, is NOT a vector quantity?

A Potential energy as a result of its position in the electric field

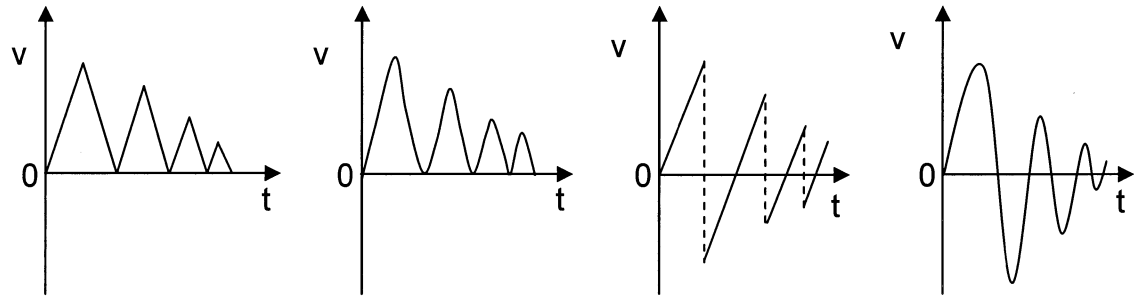
B Electric field strength

C Acceleration

D Velocity

(4)

1.3 A solid rubber ball held above a horizontal table is dropped from rest. It strikes the table and bounces several times. The collisions are **inelastic**. Which ONE of the following graphs is the best representation of the variation of the velocity **v** of the ball with time **t**? Ignore air friction.



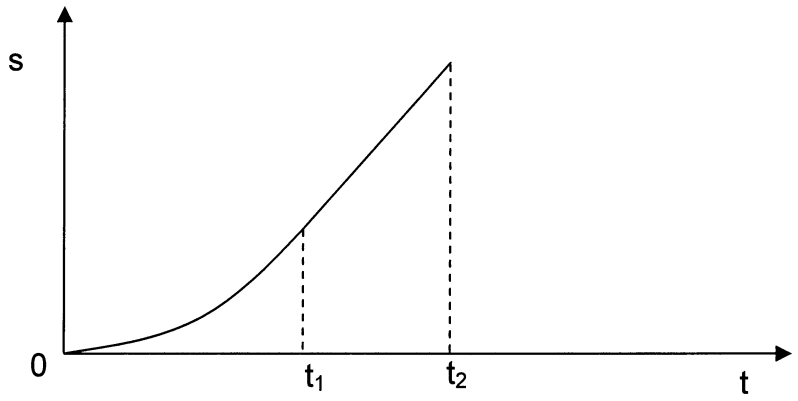
A B C D (4)

1.4 A car accelerates uniformly from rest. After travelling a distance **s** in a straight line in **t** seconds, it has a velocity **v**. At what time and distance during its motion will it reach a velocity 2**v**?

	Time	**Distance**
A	**4t**	**4s**
B	**4t**	**2s**
C	**2t**	**2s**
D	**2t**	**4s**

(4)

1.5 The following displacement-time graph for the motion of a car was obtained:

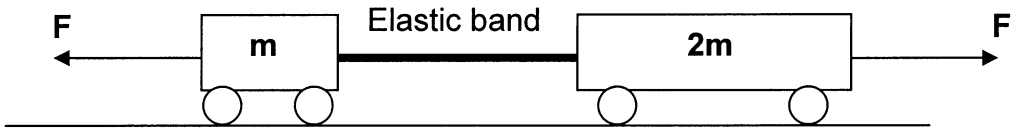


Which ONE of the following combinations concerning the acceleration and velocity of the car is true for the time intervals indicated?

	$0 - t_1$	**$t_1 - t_2$**	
	Velocity	**Acceleration**	**Velocity**
A	increases	zero	constant
B	increases	non-zero and constant	increases
C	constant	zero	constant
D	constant	non-zero and constant	increases

(4)

1.6 Two trolleys, masses **m** and **2m**, are connected by an elastic band on a frictionless surface. The trolleys are then pulled in opposite directions by two forces, each of magnitude **F**, stretching the rubber band and holding the trolleys stationary.



What is the magnitude of the force of the elastic band on the trolley of mass 2**m**?

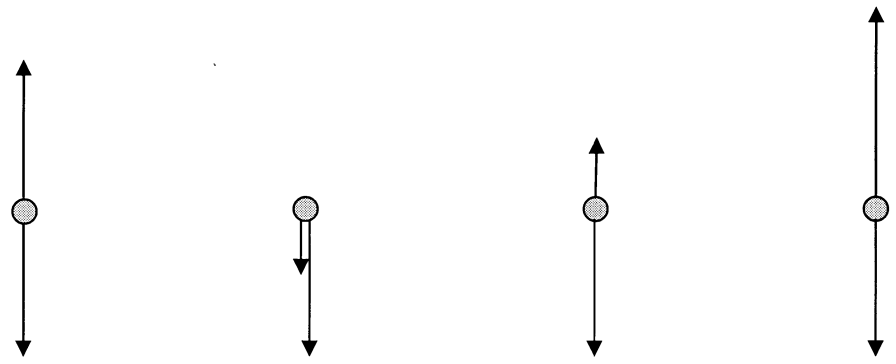
A Zero

B $\frac{2}{3}$**F**

C **F**

D 2**F** (4)

1.7 Which ONE of the following diagrams is the correct representation of the forces acting on a ball immediately after it has been thrown vertically upwards? The relative lengths of the vectors (arrows) indicate the magnitudes of the relevant forces.



A B C D (4)

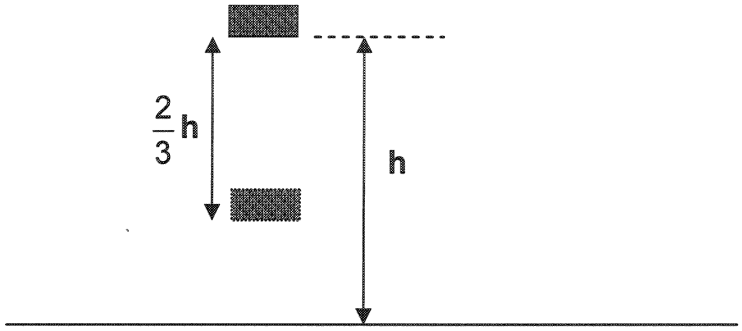
1.8 John, in a stationary elevator, suspends a spring balance from the roof of the elevator and attaches a 20 N mass piece to the spring balance. The elevator starts moving and during the time of motion he makes the following observations on the spring balance. For the first section of the motion the reading is greater than 20 N, for the second section it is 20 N and for the third section the reading is less than 20 N.

Which ONE of the following combinations is correct for the direction of the motion and the acceleration of the elevator during the first and third sections?

	Direction of motion	**Acceleration during section 1**	**Acceleration during section 3**
A	upwards	upwards	upwards
B	downwards	downwards	upwards
C	upwards	upwards	downwards
D	downwards	downwards	downwards

(4)

1.9 A brick, mass **m**, is dropped from rest from a height **h**.



Which ONE of the following combinations is the correct representation of the gravitational potential energy (E_p), relative to the lowest point, and the kinetic energy (E_k) of the brick after it has fallen two thirds of the height ($\frac{2}{3}$**h**)? Air friction can be ignored.

	E_p	E_k
A	$\frac{2}{3}$**mgh**	$\frac{2}{3}$**mgh**
B	$\frac{1}{3}$**mgh**	$\frac{2}{3}$**mgh**
C	$\frac{2}{3}$**mgh**	$\frac{1}{3}$**mgh**
D	$\frac{1}{3}$**mgh**	$\frac{1}{3}$**mgh**

(4)

1.10 A cricket ball, mass **m**, falls vertically and strikes the ground with a speed of 2**v**. It rebounds vertically with a speed of **v**. What is the magnitude of the change in its momentum?

A Zero

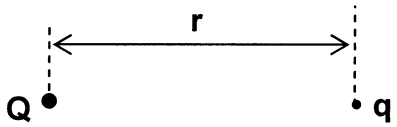
B **mv**

C 2**mv**

D 3**mv**

(4)

1.11 A unit positive test charge **q** is placed a distance **r** from a charge **Q**.

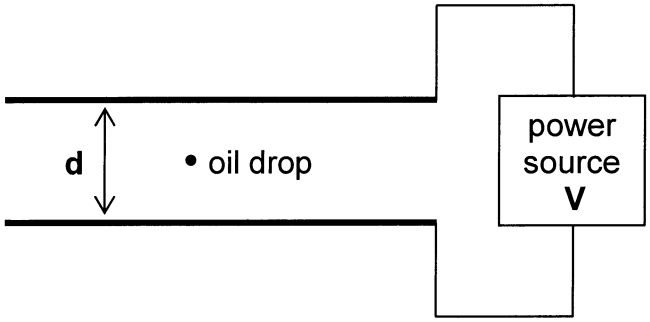


Which ONE of the following combinations of proportionalities is true for the relationship between the force experienced by the test charge **q** and the electric field causing it, as well as the strength of that electric field and the charge producing it?

	Electric field strength and force experienced by q	**Electric field strength and charge which produces the field**
A	$F \propto E$	$E \propto q$
B	$F \propto E$	$E \propto Q$
C	$F \propto \frac{1}{E}$	$E \propto q$
D	$F \propto \frac{1}{E}$	$E \propto Q$

(4)

1.12 In a Millikan-type experiment, a constant potential difference **V** is applied across two oppositely charged, parallel plates. When the plates are a distance **d** apart, a negatively charged oil drop is at rest between them in an electric field of strength **E**.

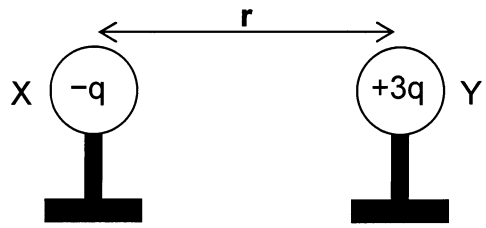


The distance between the plates is now increased to 2**d**. Which ONE of the following combinations is the correct representation of the sign of the electric charge on the top plate and the magnitude of the electric field strength?

	Charge on top plate	**Magnitude of E**
A	+	$\frac{1}{2}$**E**
B	+	2**E**
C	-	2**E**
D	-	$\frac{1}{2}$**E**

(4)

1.13 Two small, identical, metal spheres, X and Y, on insulated stands, carry charges of –q and +3q respectively. When their centres are a distance **r** apart, X exerts an electrostatic force of magnitude **F** on Y.



Y is now brought into contact with X and then moved to a point which is a distance $\frac{1}{2}\mathbf{r}$ from X. Which ONE of the following gives the magnitude of the electrostatic force that X now exerts on Y?

A $12\mathbf{F}$

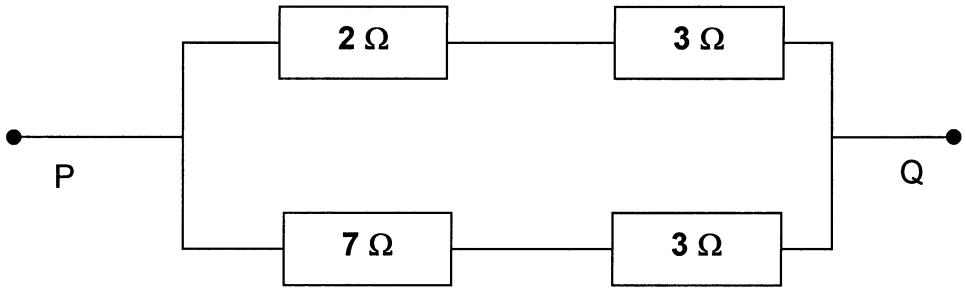
B $\frac{4}{3}\mathbf{F}$

C $\frac{3}{4}\mathbf{F}$

D $\frac{1}{12}\mathbf{F}$

(4)

1.14 In a section of a circuit represented below, a potential difference **V** is applied across PQ.



Which ONE of the following gives the current in the 7 Ω resistor?

A $\frac{\mathbf{V}}{3}$

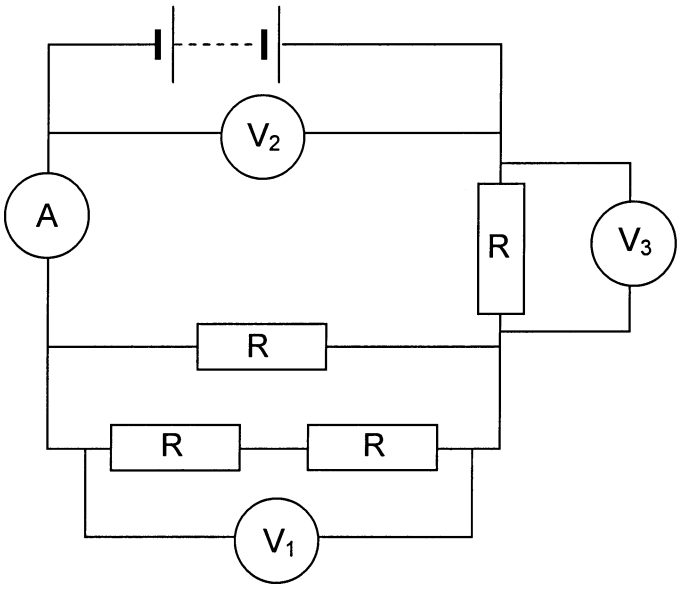
B $\frac{\mathbf{V}}{5}$

C $\frac{\mathbf{V}}{7}$

D $\frac{\mathbf{V}}{10}$

(4)

1.15 In the circuit represented below, the battery has an internal resistance. All the resistors have equal resistance.



Which ONE of the following statements concerning the voltmeter readings is true?

A Emf = $V_1 + V_2 + V_3$

B $V_1 = V_2$ and $V_1 < V_3$

C $V_2 = V_1 + V_3$

D V_2 = Emf (4)

[15 x 4 = 60]

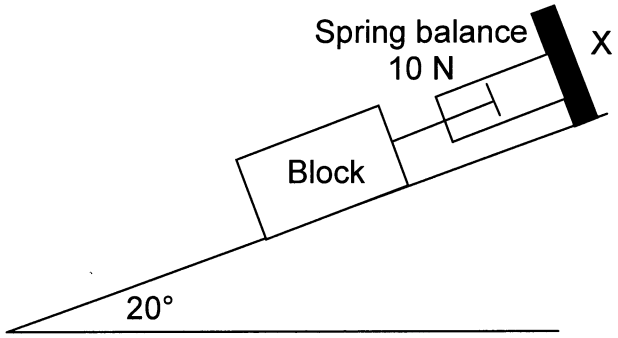
ANSWER QUESTIONS 2 TO 9 IN THE ANSWER BOOK.

INSTRUCTIONS

1. Start each question on a NEW PAGE in the ANSWER BOOK.
2. Leave a line between subsections, for example 2.1 and 2.2.
3. Show ALL the formulae, as well as the calculations, including substitutions.
4. Number the answers exactly as the questions are numbered.

QUESTION 2 [START ON A NEW PAGE]

A block is held at rest on a slope, which is inclined at 20° to the horizontal, by means of a spring balance attached to X. The spring balance registers a reading of 10 N. (Disregard friction.)



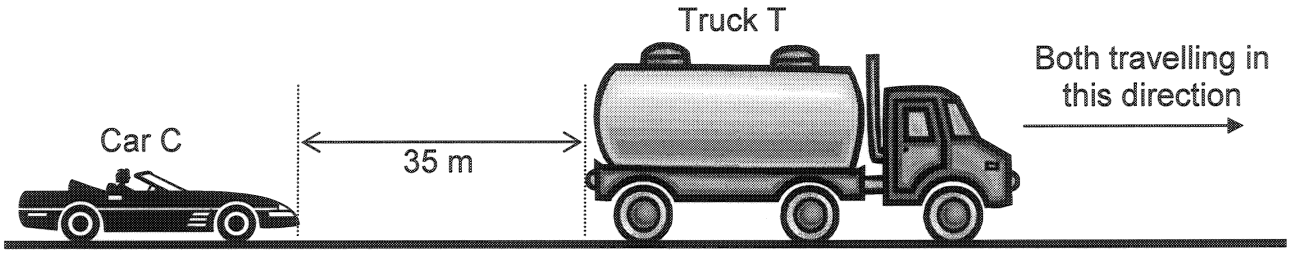
2.1 State, in words, the **triangle rule** for three forces in equilibrium. (3)

2.2 Draw a labelled force diagram (not a triangle of forces) indicating all the forces acting on the block. Also indicate at least two angles on your diagram. (4)

2.3 Calculate the mass of the block. Also draw a rough triangle of forces and indicate at least two angles in the triangle. (6)
[13]

QUESTION 3 [START ON A NEW PAGE]

A truck T and a car C are both travelling at a constant speed of 30 $m.s^{-1}$. The driver of car C follows the truck T, keeping a distance of 35 m between them. Seeing a herd of cattle ahead on the road, the driver of truck T brakes to reduce its speed uniformly to stop in 12 s. National traffic safety rules advise a following distance of 90 m at 30 $m.s^{-1}$.



3.1 Calculate the **magnitude** of the acceleration of the truck while slowing down. (5)

The driver of car C applies the brakes 0,8 s after truck T starts braking. The brakes of the car slow it down at a uniform acceleration of 2 $m.s^{-2}$.

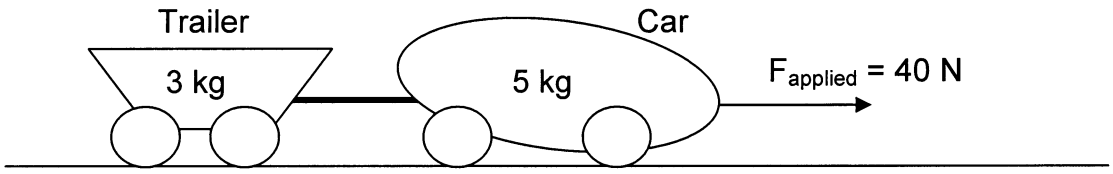
3.2 Calculate the distance travelled by the car during the 0,8 s before the brakes are applied. (4)

3.3 Calculate the distance travelled by the truck during the 12 s braking period. (4)

3.4 The car could not stop in time and collides with the truck. Prove, by means of calculations, that if the car was keeping its following distance as suggested by the national traffic department, it would have been able to stop in time. (8)
[21]

QUESTION 4 [START ON A NEW PAGE]

A toy trailer, mass 3 kg, is connected to a toy car, mass 5 kg, by means of a light, solid rod. The system is at rest on a horizontal surface. A horizontal force of 40 N is then applied to the car and the velocity of the car and trailer increase uniformly in a straight line to the right. While moving, the trailer experiences a frictional force of 3 N while the car experiences a frictional force of 5 N.



4.1 Define, in words, **Newton's Second Law of Motion**. (3)

4.2 Calculate the **magnitude** of the acceleration of the system. (Hint: Write down separate equations for the two moving objects using Newton's Second Law of Motion and then calculate the acceleration.) (8)

4.3 Calculate the **magnitude** of the force exerted by the rod on the trailer. (3)

4.4 By making use of the change in kinetic energy but **not** any equations of motion, calculate the **magnitude** of the velocity of the car, after it has travelled 10 m from rest. (8)
[22]

QUESTION 5 [START ON A NEW PAGE]

A rocket, carrying an astronaut of mass 70 kg in a space capsule, accelerates uniformly from rest to reach a height of 50 m in the first 2,5 s of its journey upwards into space. Assume that there is negligible change in mass during the first 2,5 s of its journey.

5.1 Calculate the **magnitude** of the acceleration produced by the rocket engine. (5)

The astronaut, seated in her chair, feels as if she is being pushed downwards into her seat.

5.2 Name the appropriate principle and state the law that can be used to explain why she 'is being pushed downwards into her seat'. (4)

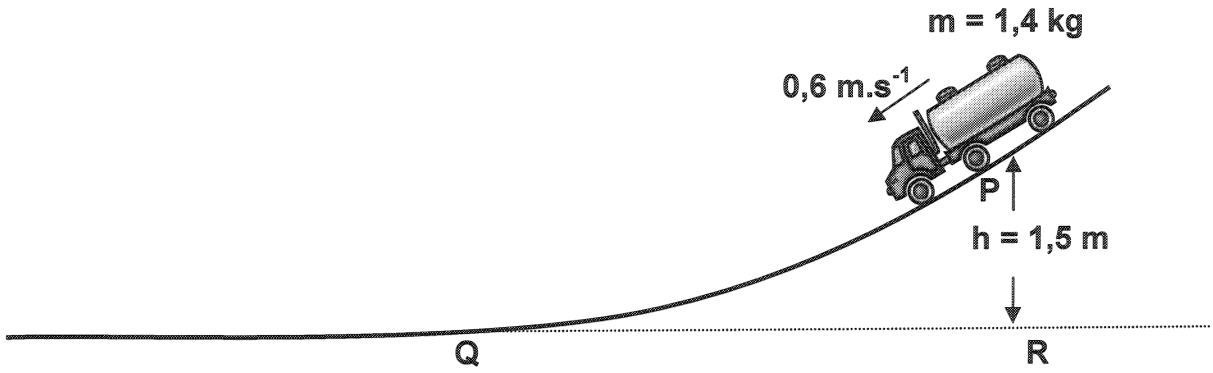
5.3 Calculate the **magnitude** of the total force the seat exerts on the astronaut during the first 2,5 s. (5)

5.4 A learner claims: "*Because the astronaut moves upwards, the force the seat exerts on the astronaut is greater than the force the astronaut exerts on the seat.*" Using a relevant Newton's law of motion, explain whether the learner is correct or not. (3)

5.5 In practice the mass of the rocket decreases as the fuel is used up. What effect will this have on the acceleration of the system if the thrust produced by the rocket engine remains the same? Explain using a relevant law of physics. (4)
[21]

QUESTION 6 [START ON A NEW PAGE]

A toy truck, mass 1,4 kg, moving down an inclined track, has a speed of 0,6 m.s^{-1} at point P, which is at a height of 1,5 m above the ground level QR. The curved section of the track, PQ, is 1,8 m long. When the truck reaches point Q it has a speed of 3 m.s^{-1}. There is friction between the track and the truck.



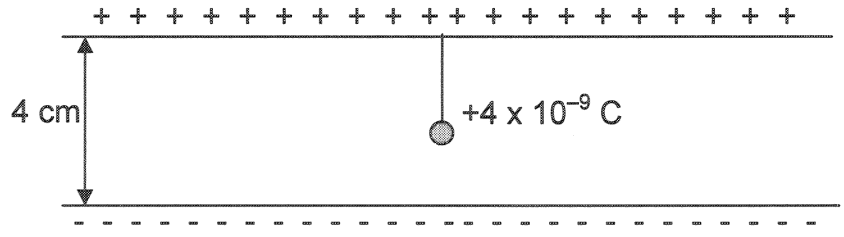
6.1 Is mechanical energy conserved? Explain. (3)

6.2 Calculate the work done by friction on the truck as it moves from P to Q. (8)

6.3 Assume that the **average frictional force** between the track and the truck is constant along PQ and calculate the average frictional force experienced by the truck as it moves along PQ. (4)
[15]

QUESTION 7 [START ON A NEW PAGE]

Sonali suspends a small ball, mass 2 x 10^{-4} kg, between two oppositely charged, parallel plates, 4 cm apart, using a light, inelastic thread. The ball has a uniformly distributed, positive charge of +4 x 10^{-9} C. A potential difference of 1,4 x 10^{4} V applied across the plates, with the top plate positive, is just enough to cause the thread to break.



7.1 Draw a diagram of the plates showing the electric field pattern between the plates. (4)

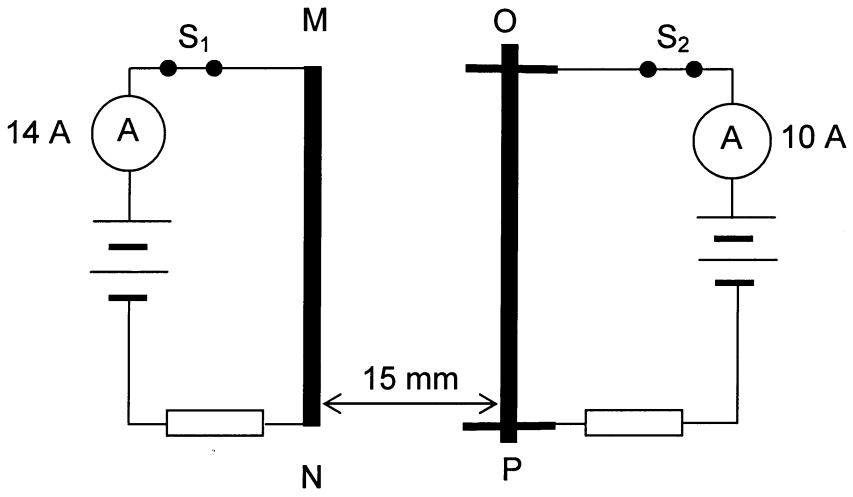
7.2 Draw a labelled force diagram of all the forces acting on the ball before the thread breaks. (3)

7.3 Determine the breaking strength of the thread in N. (9)
[16]

QUESTION 8 [START ON A NEW PAGE]

Shastra wants to determine the magnetic force that one current-carrying conductor, MN, exerts on another parallel conductor OP. The diagram below represents the apparatus she uses.

OP is a light, cylindrical conductor that is able to maintain electrical contact when it rolls to the right or left. With switches S_1 and S_2 closed, the current in conductor MN is 14 A and in conductor OP is 10 A. MN is 25 cm in length and the initial distance between MN and OP is 15 mm.



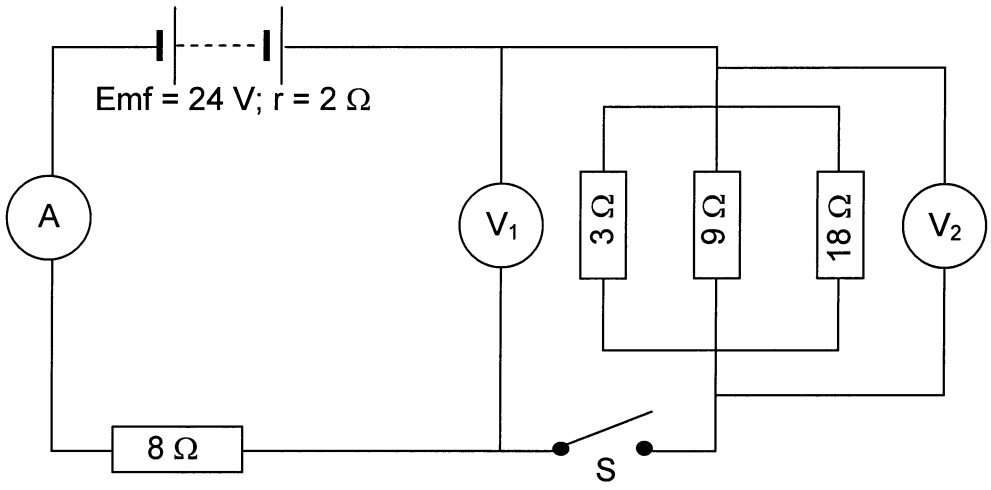
8.1 Define, in words, **the ampere**. (4)

8.2 In which direction does conductor OP roll when both switches S_1 and S_2 are closed? State ONLY **towards MN** or **away from MN**. (2)

8.3 Calculate the **magnitude** of the force that conductor OP experiences when the switches are closed. (6)
[12]

QUESTION 9 [START ON A NEW PAGE]

In the circuit represented below, the battery has an emf of 24 V and an internal resistance of 2 Ω. Voltmeter V_1 is connected as indicated and voltmeter V_2 is connected across the three parallel resistors. The resistances of the connecting wires and ammeter can be ignored.



9.1 Define, in words, a **coulomb**. (3)

Switch S is open.

9.2 What is the reading on V_1? (2)

9.3 What is the reading on V_2? (2)

Switch S is now closed.

9.4 Calculate the effective resistance of the entire circuit. (7)

9.5 Calculate the charge moving past a cross section of the 8 Ω resistor in one minute. (6)
[20]

TOTAL QUESTION 1: 60
TOTAL QUESTIONS 2 - 9: 140
GRAND TOTAL: 200

DEPARTMENT OF EDUCATION
DEPARTEMENT VAN ONDERWYS

SENIOR CERTIFICATE EXAMINATION
SENIORSERTIFIKAAT-EKSAMEN

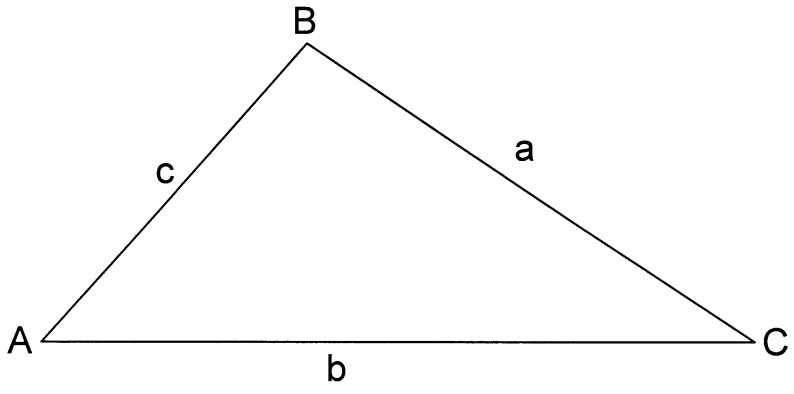
DATA FOR PHYSICAL SCIENCE
PAPER I (PHYSICS)

GEGEWENS VIR NATUUR- EN SKEIKUNDE
VRAESTEL I (FISIKA)

TABLE 1: PHYSICAL CONSTANTS
TABEL 1: FISIESE KONSTANTES

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Acceleration due to gravity *Swaartekragversnelling*	g	$10\ m.s^{-2}$
Gravitational constant *Swaartekragkonstante*	G	$6,7 \times 10^{-11}\ N.m^2.kg^{-2}$
Charge on electron *Lading van elektron*	e^-	$-1,6 \times 10^{-19}\ C$

MATHEMATICAL AIDS/*WISKUNDIGE HULPMIDDELS*



$$\frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c}$$

$$c^2 = a^2 + b^2 - 2ab\cos C$$

TABLE 2: FORMULAE
TABEL 2: FORMULES

MOTION/*BEWEGING*

$v = u + at$	$s = ut + \frac{1}{2}at^2$
$v^2 = u^2 + 2as$	$s = \left(\frac{u+v}{2}\right)t$

FORCE/*KRAG*

$F_{res} = ma$	$p = mv$
$F = \frac{Gm_1m_2}{r^2}$	$F\Delta t = \Delta p = mv - mu$

WORK, ENERGY AND POWER/*ARBEID, ENERGIE EN DRYWING*

$W = Fs$	$E_p = mgh$
$P = \frac{W}{t}$	$E_k = \frac{1}{2}mv^2$

ELECTROSTATICS/*ELEKTROSTATIKA*

$F = \frac{kQ_1Q_2}{r^2}$ $(k = 9 \times 10^9\ N.m^2.C^{-2})$	$V = \frac{W}{Q}$
$E = \frac{F}{q}$	$W = QEs$
$E = \frac{kQ}{r^2}$ $(k = 9 \times 10^9\ N.m^2.C^{-2})$	$E = \frac{V}{d}$

CURRENT ELECTRICITY/*STROOMELEKTRISITEIT*

$Q = It$	$emf/emk = I(R + r)$
$R = r_1 + r_2 + r_3 + \ldots$	$F = \frac{kI_1 I_2 \ell}{d}$ $(k = 2 \times 10^{-7}\ N.A^{-2})$
$\frac{1}{R} = \frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3} + \ldots$	$W = VIt = I^2Rt = \frac{V^2t}{R}$
$R = \frac{V}{I}$	$P = VI = I^2R = \frac{V^2}{R}$