H

National
Qualifications
2023

X857/76/12

Physics
Paper 1 — Multiple choice

WEDNESDAY, 17 MAY

9:00 AM – 9:45 AM

Total marks — 25

Attempt ALL questions.

You may use a calculator.

Instructions for the completion of Paper 1 are given on *page 02* of your answer booklet X857/76/02.

Record your answers on the answer grid on *page 03* of your answer booklet.

Reference may be made to the data sheet on *page 02* of this question paper and to the relationships sheet X857/76/22.

Space for rough work is provided at the end of this booklet.

Before leaving the examination room you must give your answer booklet to the Invigilator; if you do not, you may lose all the marks for this paper.

X8577612

A/HTP

DATA SHEET

COMMON PHYSICAL QUANTITIES

Quantity	Symbol	Value	Quantity	Symbol	Value
Speed of light in vacuum	c	3.00×10^{8} m s^{-1}	Planck's constant	h	6.63×10^{-34} J s
Magnitude of the charge on an electron	e	1.60×10^{-19} C	Mass of electron	m_e	9.11×10^{-31} kg
Universal Constant of Gravitation	G	6.67×10^{-11} m^{3} kg^{-1} s^{-2}	Mass of neutron	m_n	1.675×10^{-27} kg
Gravitational acceleration on Earth	g	9.8 m s^{-2}	Mass of proton	m_p	1.673×10^{-27} kg
Hubble's constant	H_0	2.3×10^{-18} s^{-1}			

REFRACTIVE INDICES

The refractive indices refer to sodium light of wavelength 589 nm and to substances at a temperature of 273 K.

Substance	Refractive index	Substance	Refractive index
Diamond	2.42	Water	1.33
Crown glass	1.50	Air	1.00

SPECTRAL LINES

Element	Wavelength (nm)	Colour
Hydrogen	656	Red
	486	Blue-green
	434	Blue-violet
	410	Violet
	397	Ultraviolet
	389	Ultraviolet
Sodium	589	Yellow

Element	Wavelength (nm)	Colour
Cadmium	644	Red
	509	Green
	480	Blue

Lasers

Element	Wavelength (nm)	Colour
Carbon dioxide	9550 10 590	Infrared
Helium-neon	633	Red

PROPERTIES OF SELECTED MATERIALS

Substance	Density (kg m^{-3})	Melting point (K)	Boiling point (K)
Aluminium	2.70×10^{3}	933	2623
Copper	8.96×10^{3}	1357	2853
Ice	9.20×10^{2}	273	. . . .
Sea Water	1.02×10^{3}	264	377
Water	1.00×10^{3}	273	373
Air	1.29	. . . .	. . . .
Hydrogen	9.0×10^{-2}	14	20

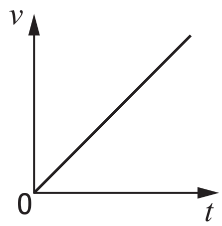
The gas densities refer to a temperature of 273 K and a pressure of 1.01×10^{5} Pa.

Total marks — 25

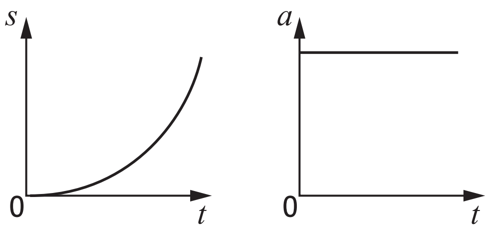
Attempt ALL questions

1. A cyclist is travelling along a straight, level road.

A velocity-time (v-t) graph of the motion of the cyclist is shown.



Which pair of displacement-time (s-t) and acceleration-time (a-t) graphs represent the motion of the cyclist?

A


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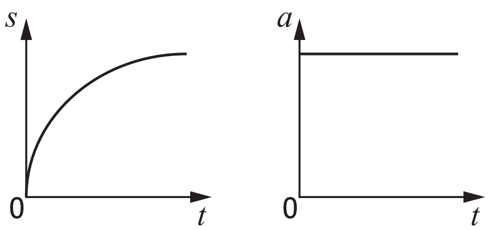

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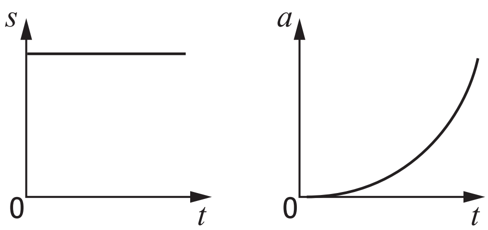
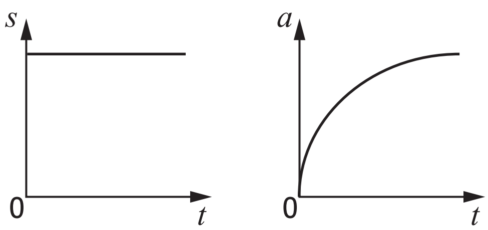


D


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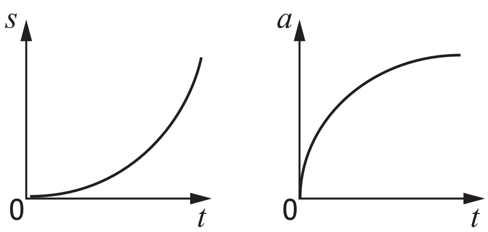


2. A hot air balloon is moving vertically.

At a height of 50 m a sandbag is released.

The sandbag takes 3.0 s to reach the ground.

The effects of air resistance can be ignored.

The initial velocity of the sandbag on release is

A 2.0 $m\,s^{-1}$ upwards

B 2.0 $m\,s^{-1}$ downwards

C 17 $m\,s^{-1}$ upwards

D 17 $m\,s^{-1}$ downwards

E 31 $m\,s^{-1}$ upwards.

3. The momentum of an object of mass 4 kg is 20 $kg\,m\,s^{-1}$.

The kinetic energy of the object is

A 10 J

B 50 J

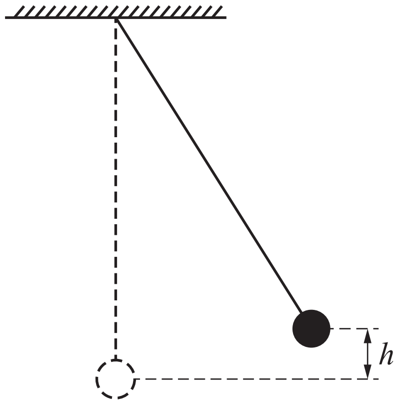
C 100 J

D 400 J

E 800 J.

4. A pendulum bob of mass m is released from rest at height h.

The bob reaches a speed v at the lowest point of its swing.



Neglecting air resistance, the speed of the bob at its lowest point is doubled by

A changing the height to $4h$

B changing the height to $2h$

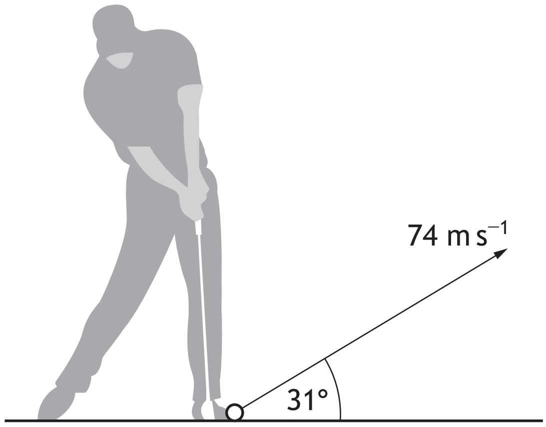
C changing the height to $\frac{h}{2}$

D changing the mass of the bob to $2m$

E changing the mass of the bob to $\frac{m}{2}$.

[Turn over

5. A golfer strikes a golf ball as shown.



The ball leaves the club with an initial velocity of 74 m s^{-1} at an angle of 31° to the horizontal.

Which row in the table shows the horizontal and vertical components of the initial velocity of the golf ball?

	Horizontal component of the initial velocity of the golf ball (m s^{-1})	**Vertical component of the initial velocity of the golf ball (m s^{-1})**
A	38	44
B	38	63
C	44	38
D	63	38
E	63	44

6. A satellite of mass 620 kg is placed into an Earth orbit of radius 23 000 km.

The mass of the Earth is 6.0×10^{24} kg.

The gravitational force that the satellite experiences from the Earth in this orbit is

A 4.7×10^{2} N

B 4.7×10^{8} N

C 1.1×10^{10} N

D 1.1×10^{13} N

E 6.9×10^{13} N.

7. Muons are created in the upper atmosphere of the Earth.

The mean lifetime of these muons in their frame of reference is 2.20 μs.

The muons are travelling at $0.99c$ relative to an observer on Earth.

The observer measures the mean lifetime of these muons as

A 1.56×10^{-2} s

B 2.20×10^{-3} s

C 1.11×10^{-4} s

D 1.56×10^{-5} s

E 3.10×10^{-7} s.

8. Evidence supporting the existence of dark energy comes from

A estimations of the mass of galaxies

B the darkness of the sky (Olbers' paradox)

C large numbers of galaxies showing redshift, rather than blueshift

D the accelerating rate of expansion of the Universe

E the abundance of the elements hydrogen and helium in the Universe.

[Turn over

9. A student makes the following statements about the emitted radiation from stellar objects.

I The peak wavelength of emitted radiation is longer for hotter objects than for cooler objects.

II A 'blue' star is likely to be hotter than a 'red' star.

III The radiation emitted per unit surface area per unit time is greater for hotter objects.

Which of these statements is/are correct?

A I only

B II only

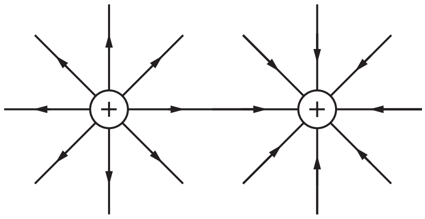
C III only

D I and III only

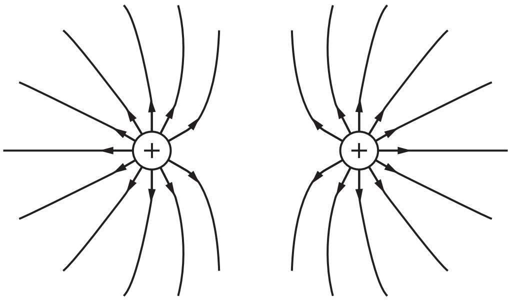
E II and III only

10. Which of the following diagrams represents the electric field pattern between two identical positively charged particles?

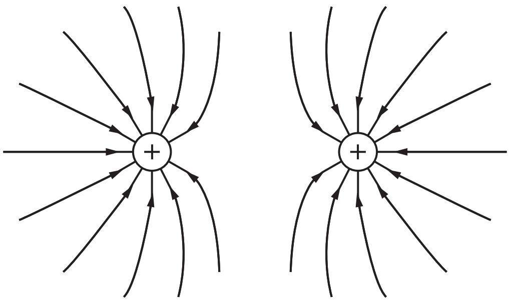
A



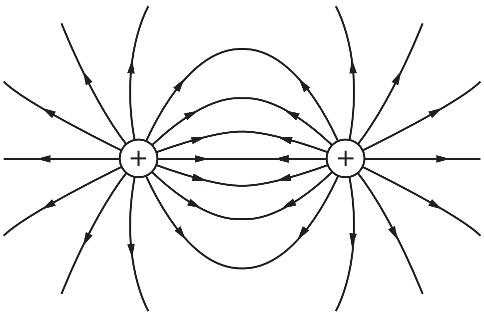
B



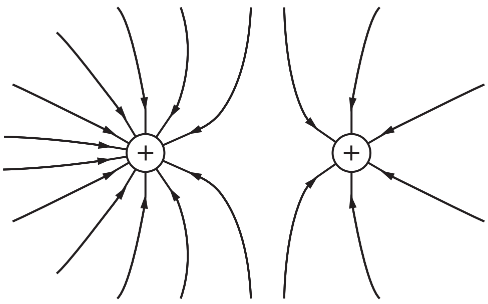
C



D



E



[Turn over

11. A neutron consists of one up quark and two down quarks.

A neutron is a

A gluon

B meson

C baryon

D lepton

E boson.

12. The following statement represents a nuclear fusion reaction.

$$^{3}_{1}H + ^{2}_{1}H \rightarrow ^{4}_{2}He + ^{1}_{0}n$$

The total mass of the particles before the reaction is 8.347×10^{-27} kg.

The total mass of the particles after the reaction is 8.317×10^{-27} kg.

The energy released in this reaction is

A 3.0×10^{-29} J

B 9.0×10^{-21} J

C 1.4×10^{-12} J

D 2.7×10^{-12} J

E 7.5×10^{-10} J.

13. A student makes the following statements about wave particle duality.

I The photoelectric effect is evidence supporting the particle model of light.

II Interference is evidence supporting the wave model of light.

III Photons of sufficient energy can eject electrons from the surface of metals.

Which of these statements is/are correct?

A I only

B II only

C III only

D I and III only

E I, II and III

14. Electromagnetic radiation of frequency 9.0×10^{14} Hz is incident on a clean, negatively charged metal surface.

The work function of the metal is 6.1×10^{-19} J.

There is no photoelectric emission from this metal caused by this radiation.

This is explained by the fact that

A photoemission can only occur from a positively charged metal surface

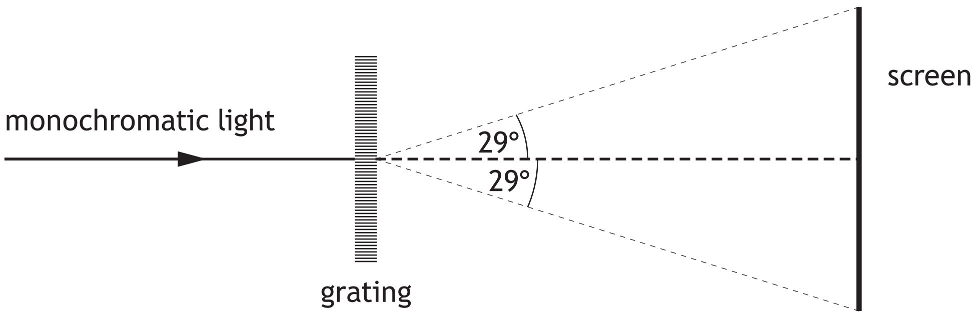
B the wavelength of the incident radiation is too short

C the frequency of the incident radiation is less than the threshold frequency of this metal

D the work function of the metal is less than the energy of the incident photons

E the number of photons per second incident on the surface of the metal is too low.

15. A ray of monochromatic light is incident on a grating. An interference pattern is observed on the screen.



The angle between the central maximum and the maximum observed at the edge of the screen is 29°.

The wavelength of the light is 605 nm.

The separation of the slits on the grating is 5.0×10^{-6} m.

The total number of maxima observed on the screen is

A 4

B 7

C 8

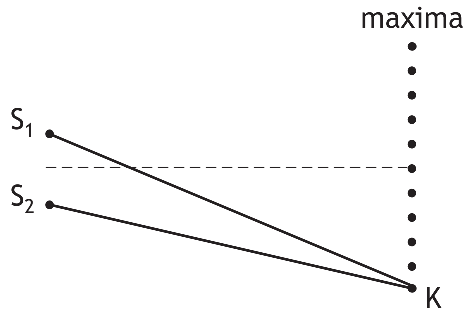
D 9

E 15.

[Turn over

16. Waves from coherent sources, S_1 and S_2, produce an interference pattern.

Maxima are detected at the positions shown.



The path difference $S_1K - S_2K$ is 154 mm.

The wavelength of the waves is

A 14.0 mm

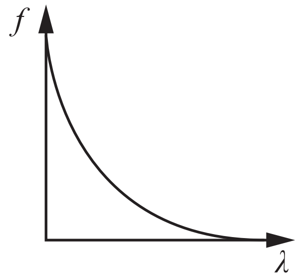
B 15.4 mm

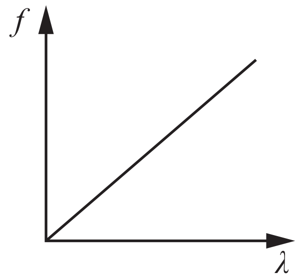
C 25.7 mm

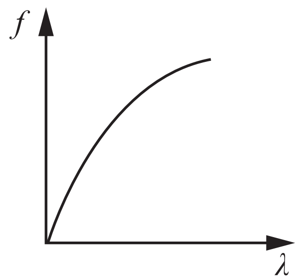
D 28.0 mm

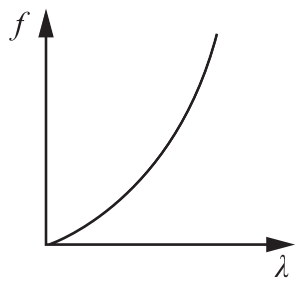
E 30.8 mm.

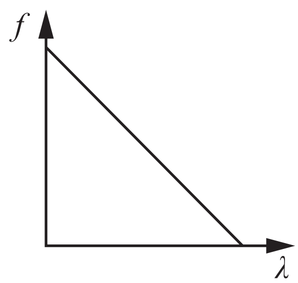
17. Which graph shows the relationship between frequency f and wavelength λ of photons of electromagnetic radiation?

A


B


C


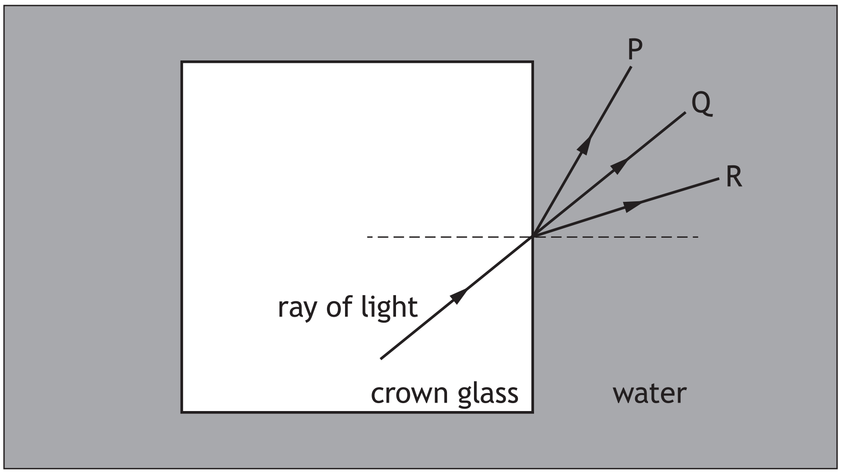
D


E


[Turn over

18. A ray of monochromatic light travels from a crown glass block into water.

The diagram shows three paths P, Q, and R for the ray of light in the water.



Which row in the table shows what happens to the speed and the wavelength, and the path the ray of light follows in the water?

	Speed	Wavelength	Path
A	decreases	decreases	R
B	decreases	decreases	P
C	stays the same	stays the same	Q
D	increases	increases	R
E	increases	increases	P

19. An AC power supply of negligible internal resistance is connected to an 8.0 Ω resistor.

The rms voltage of the power supply is 5.0 V.

The peak power dissipated in the 8.0 Ω resistor is

A 0.44 W

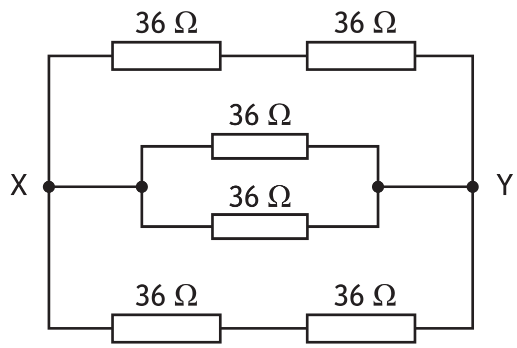
B 0.63 W

C 1.4 W

D 3.1 W

E 6.3 W.

20. Six 36 Ω resistors are connected as shown.



The total resistance between points X and Y is

A 6.0 Ω

B 8.0 Ω

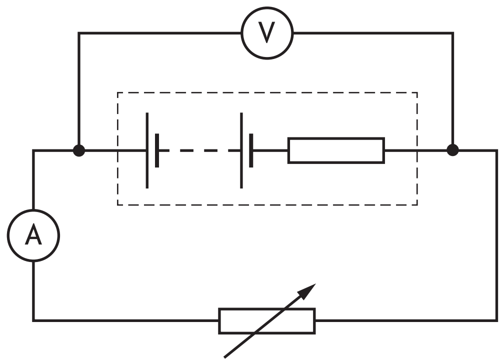
C 12 Ω

D 18 Ω

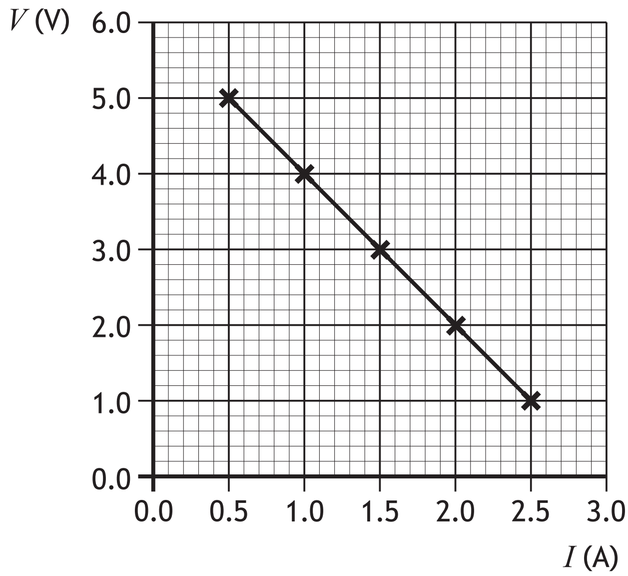
E 24 Ω.

[Turn over

21. A student carries out an experiment to determine the EMF and internal resistance of a battery using the circuit shown.



The resistance of the variable resistor is altered and readings of voltage V and current I are taken. These readings are used to produce the following graph.



Which row in the table shows the EMF and internal resistance of the battery?

	EMF (V)	Internal resistance (Ω)
A	2.0	6.0
B	5.0	0.50
C	5.0	2.0
D	6.0	0.50
E	6.0	2.0

22. One coulomb per volt is equivalent to one

A hertz

B farad

C ohm

D joule

E ampere.

23. A student makes the following statements about metals, insulators, and semiconductors.

I In some metals, the valence and conduction bands overlap and each band is partially filled.

II The band gap between the valence band and the conduction band in an insulator is large compared to the band gap in a semiconductor.

III An increase in temperature decreases the conductivity of a semiconductor.

Which of these statements is/are correct?

A I only

B II only

C I and II only

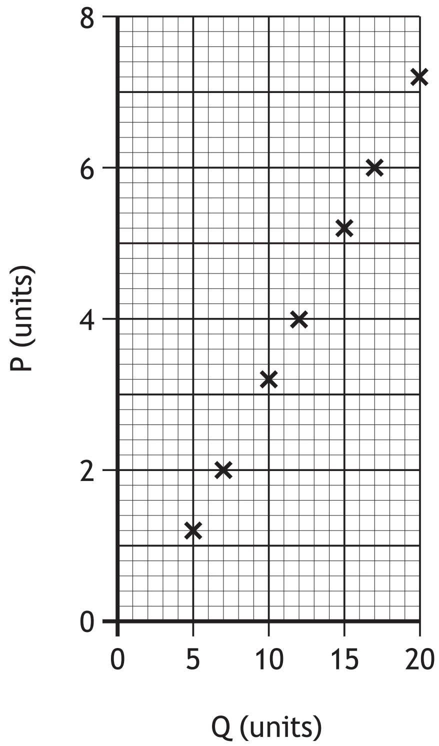
D I and III only

E II and III only

[Turn over

24. A group of students carry out an experiment to investigate how quantity P depends on quantity Q.

The results of the experiment are plotted on the graph shown.



A physics textbook states that quantity P is directly proportional to quantity Q.

The students make the following statements about the line of best fit that should be drawn using all the data points plotted.

I The line of best fit passes through the origin.

II The line of best fit does not pass through the origin.

III The line of best fit suggests the measurements have been affected by a systematic uncertainty.

Which of these statements is/are correct?

A I only

B II only

C III only

D I and III only

E II and III only

25. The mass m of a vibrating string can be determined using the following relationship.

$$f = \sqrt{\frac{T}{4mL}}$$

where f is the fundamental frequency

T is the tension

L is the length of the string.

For a particular string the following measurements are recorded:

$f = 110$ Hz

$T = 92$ N

$L = 0.63$ m.

Based on this information the mass of this string is

A 3.0×10^{-3} kg

B 1.2×10^{-2} kg

C 3.3×10^{-1} kg

D 5.8×10^{-1} kg

E 3.3×10^{2} kg.

[END OF QUESTION PAPER]

SPACE FOR ROUGH WORK