X069/12/02

NATIONAL QUALIFICATIONS 2012

MONDAY, 28 MAY
1.00 PM – 3.30 PM

PHYSICS
HIGHER

Read Carefully

Reference may be made to the Physics Data Booklet.

1 All questions should be attempted.

Section A (questions 1 to 20)

2 Check that the answer sheet is for Physics Higher (Section A).

3 For this section of the examination you must use an **HB pencil** and, where necessary, an eraser.

4 Check that the answer sheet you have been given has **your name**, **date of birth**, **SCN** (Scottish Candidate Number) and **Centre Name** printed on it.

Do not change any of these details.

5 If any of this information is wrong, tell the Invigilator immediately.

6 If this information is correct, **print** your name and seat number in the boxes provided.

7 There is **only one correct** answer to each question.

8 Any rough working should be done on the question paper or the rough working sheet, **not** on your answer sheet.

9 At the end of the exam, put the **answer sheet for Section A inside the front cover of your answer book**.

10 Instructions as to how to record your answers to questions 1–20 are given on page three.

Section B (questions 21 to 31)

11 Answer the questions numbered 21 to 31 in the answer book provided.

12 **All answers must be written clearly and legibly in ink**.

13 Fill in the details on the front of the answer book.

14 Enter the question number clearly in the margin of the answer book beside each of your answers to questions 21 to 31.

15 Care should be taken to give an appropriate number of signiicant igures in the inal answers to calculations.

16 Where additional paper, eg square ruled paper, is used, write your name and SCN (Scottish Candidate Number) on it and place it inside the front cover of your answer booklet.

X069/12/02

SQA

DATA SHEET

COMMON PHYSICAL QUANTITIES

Quantity	*Symbol*	*Value*	*Quantity*	*Symbol*	*Value*
Speed of light in vacuum	c	$3{\cdot}00 \times 10^{8}\ \mathrm{m\,s^{-1}}$	Mass of electron	m_e	$9{\cdot}11 \times 10^{-31}\ \mathrm{kg}$
Magnitude of the charge on an electron	e	$1{\cdot}60 \times 10^{-19}\ \mathrm{C}$	Mass of neutron	m_n	$1{\cdot}675 \times 10^{-27}\ \mathrm{kg}$
Gravitational acceleration on Earth	g	$9{\cdot}8\ \mathrm{m\,s^{-2}}$	Mass of proton	m_p	$1{\cdot}673 \times 10^{-27}\ \mathrm{kg}$
Planck's constant	h	$6{\cdot}63 \times 10^{-34}\ \mathrm{J\,s}$			

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	Infrared
Helium-neon	633	Red

PROPERTIES OF SELECTED MATERIALS

Substance	*Density*/kg m^{-3}	*Melting Point*/K	*Boiling Point*/K
Aluminium	$2{\cdot}70 \times 10^{3}$	933	2623
Copper	$8{\cdot}96 \times 10^{3}$	1357	2853
Ice	$9{\cdot}20 \times 10^{2}$	273	. . . .
Sea Water	$1{\cdot}02 \times 10^{3}$	264	377
Water	$1{\cdot}00 \times 10^{3}$	273	373
Air	1·29	. . . .	. . . .
Hydrogen	$9{\cdot}0 \times 10^{-2}$	14	20

The gas densities refer to a temperature of 273 K and a pressure of $1{\cdot}01 \times 10^{5}$ Pa.

SECTION A

For questions 1 to 20 in this section of the paper the answer to each question is either A, B, C, D or E. Decide what your answer is, then, using your pencil, put a horizontal line in the space provided—see the example below.

EXAMPLE

The energy unit measured by the electricity meter in your home is the

A kilowatt-hour

B ampere

C watt

D coulomb

E volt.

The correct answer is **A**—kilowatt-hour. The answer **A** has been clearly marked in **pencil** with a horizontal line (see below).

Changing an answer

If you decide to change your answer, carefully erase your first answer and, using your pencil, fill in the answer you want. The answer below has been changed to **E**.

[Turn over

SECTION A

Answer questions 1–20 on the answer sheet.

1. Which of the following contains one vector and two scalar quantities?

   A force, time and acceleration

   B power, momentum and velocity

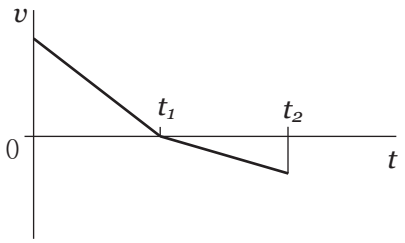
   C acceleration, velocity and force

   D mass, distance and speed

   E acceleration, time and speed

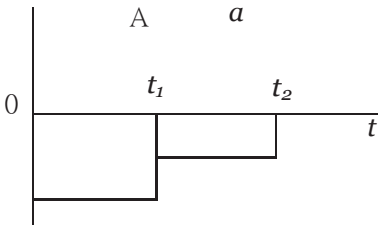
2. A trolley travels along a straight track.

   The graph shows how the velocity v of the trolley varies with time t.

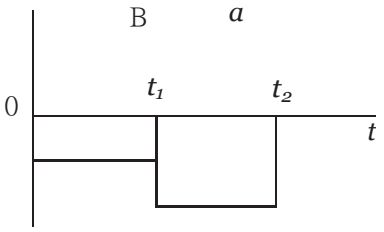


   Which graph shows how the acceleration a of the trolley varies with time t?

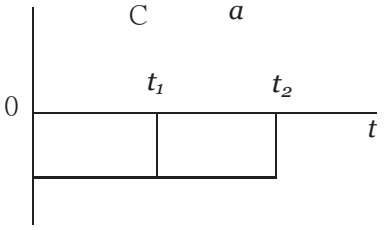
A



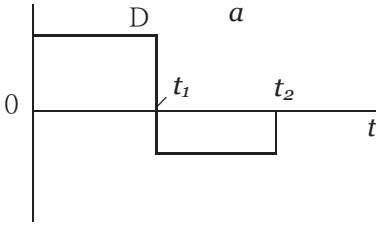
B



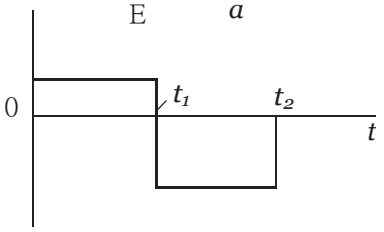
C



D



E



3. A rocket of mass 200 kg accelerates vertically upwards from the surface of a planet at $2{\cdot}0\,m\,s^{-2}$.

The gravitational field strength on the planet is $4{\cdot}0\,N\,kg^{-1}$.

What is the size of the force being exerted by the rocket's engines?

A 400N

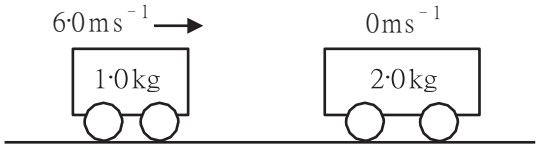
B 800N

C 1200N

D 2000N

E 2400N

4. The diagram shows the masses and velocities of two trolleys just before they collide on a level bench.



After the collision, the trolleys move along the bench joined together.

How much kinetic energy is lost in this collision?

A 0J

B 6·0J

C 12J

D 18J

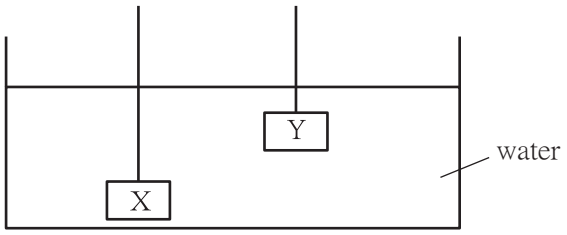
E 24J

5. A fixed mass of gas condenses at atmospheric pressure to form a liquid.

Which row in the table shows the approximate increase in density and the approximate decrease in spacing between molecules?

	Approximate increase in density	*Approximate decrease in spacing between molecules*
A	10 times	10 times
B	10 times	1000 times
C	1000 times	10 times
D	1000 times	1000 times
E	1 000 000 times	1000 times

6. Two identical blocks are suspended in water at different depths as shown.



A student makes the following statements.

I The buoyancy force on block Y is greater than the buoyancy force on block X.

II The pressure on the bottom of block X is greater than the pressure on the bottom of block Y.

III The pressure on the top of block X is greater than the pressure on the top of block Y.

Which of the statements is/are correct?

A I only

B II only

C I and II only

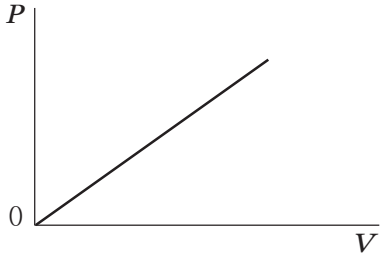
D II and III only

E I, II and III

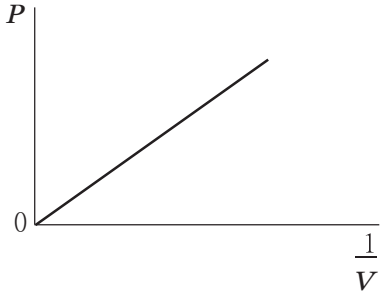
[Turn over

7. Which of the following graphs shows the relationship between the pressure P and the volume V of a fixed mass of gas at constant temperature?

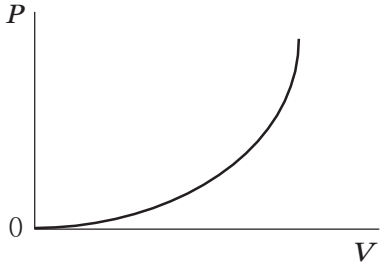
A



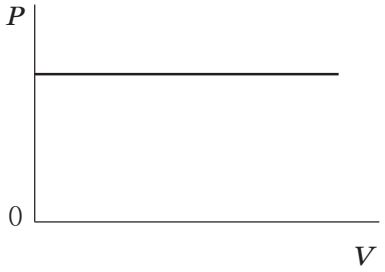
B



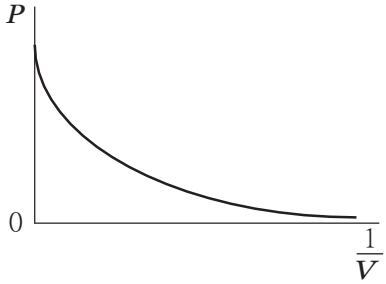
C



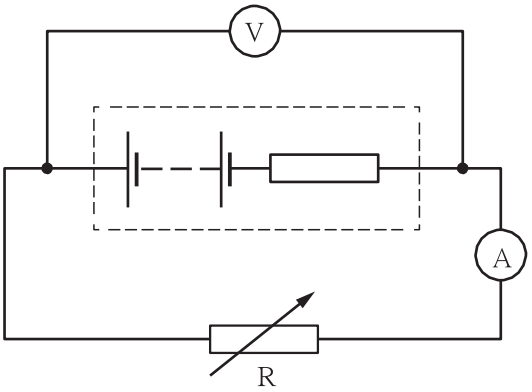
D



E

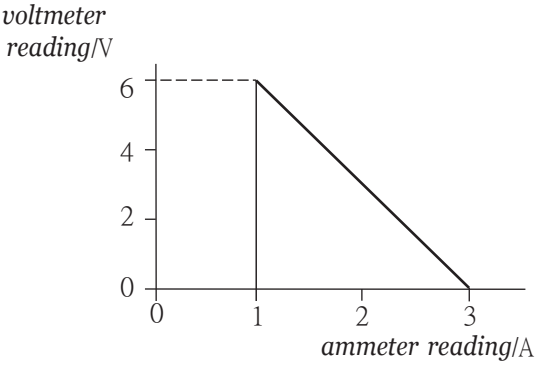


8. A circuit is set up as shown.



The variable resistor R is adjusted and a series of readings taken from the voltmeter and ammeter.

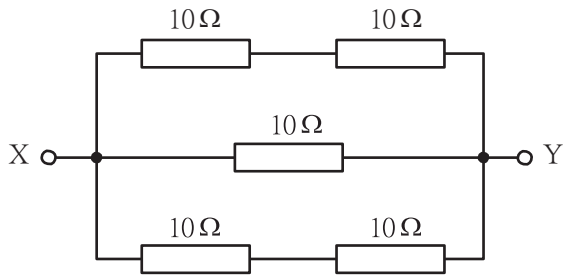
The graph shows how the voltmeter reading varies with the ammeter reading.



Which row in the table shows the values for the e.m.f. and internal resistance of the battery in the circuit?

	e.m.f./V	*internal resistance*/Ω
A	6	2
B	6	3
C	9	2
D	9	3
E	9	6

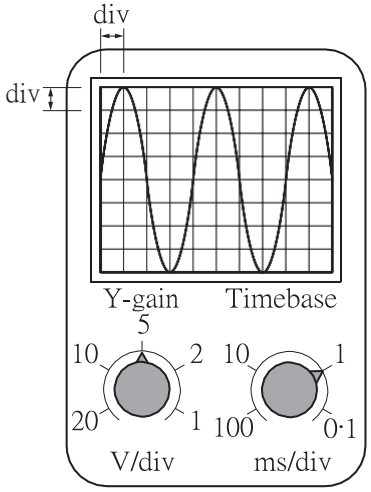
9. The diagram shows part of an electrical circuit.



What is the resistance between X and Y?

A 0·2 Ω
B 5 Ω
C 10 Ω
D 20 Ω
E 50 Ω

10. An alternating voltage is displayed on an oscilloscope screen. The Y-gain and the timebase settings are shown.



Which row in the table gives the values for the peak voltage and frequency of the signal?

	Peak voltage/V	*Frequency*/Hz
A	10	100
B	10	250
C	20	250
D	10	500
E	20	1000

11. A student carries out an experiment to find the capacitance of a capacitor. The charge on the capacitor is measured for different values of p.d. across the capacitor. The results are shown.

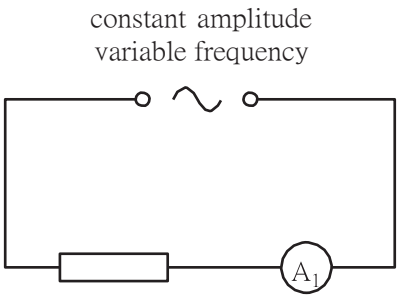
charge on capacitor/μC	*p.d. across capacitor*/V
1·9	1·0
4·6	2·0
9·6	4·0

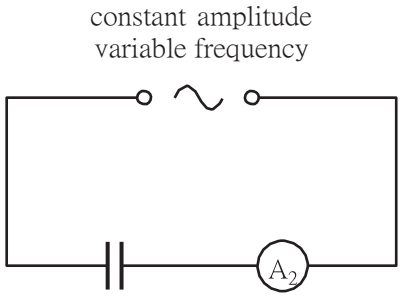
The best estimate of the capacitance is

A 1·9 μF
B 2·2 μF
C 2·3 μF
D 2·4 μF
E 2·6 μF.

[Turn over

12. The circuits below have identical a.c. supplies which are set at a frequency of 200 Hz.



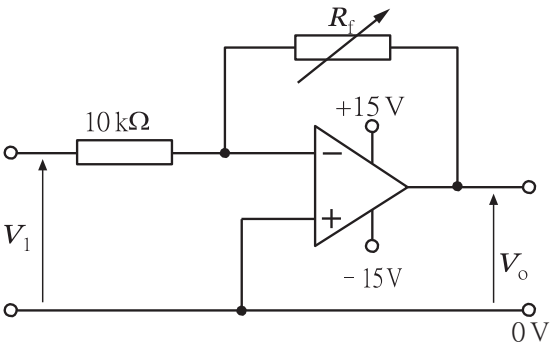


The frequency of each a.c. supply is now increased to 500 Hz.

What happens to the readings on the ammeters A_1 and A_2?

	A_1	A_2
A	increases	decreases
B	decreases	increases
C	no change	no change
D	no change	decreases
E	no change	increases

13. An op-amp circuit is set up as shown.



The resistance of R_f can be varied between 0 and 100 kΩ.

When the input voltage V_1 is +2 V a possible value of the output voltage V_o is

A +20 V

B +10 V

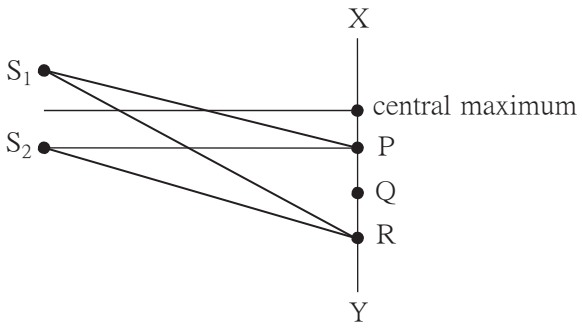
C +2 V

D – 10 V

E – 20 V.

14. S_1 and S_2 are sources of coherent waves.

An interference pattern is obtained between X and Y.



The first order maximum occurs at P, where S_1P = 200 mm and S_2P = 180 mm.

For the third order maximum, at R, the path difference (S_1R – S_2R) is

A 20 mm

B 30 mm

C 40 mm

D 50 mm

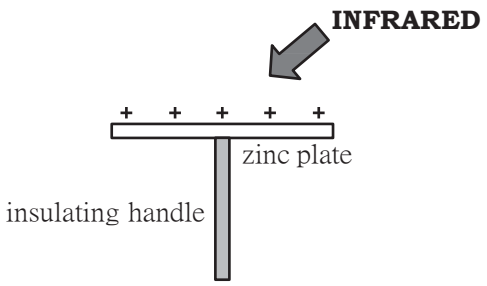
E 60 mm.

15. Clean zinc plates are mounted on insulating handles and then charged.

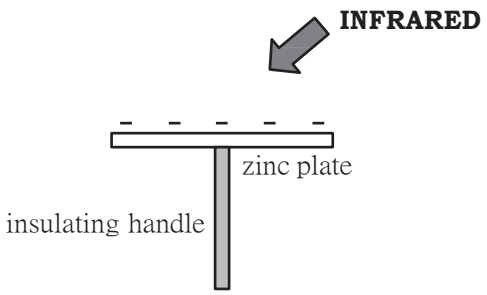
Different types of electromagnetic radiation are now incident on the plates as shown.

Which of the zinc plates is most likely to discharge due to photoelectric emission?

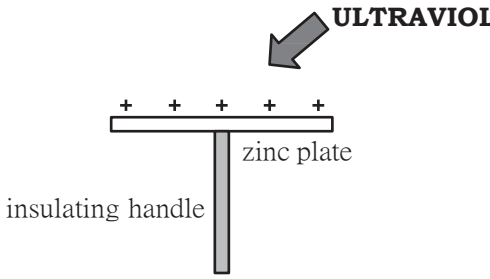
A



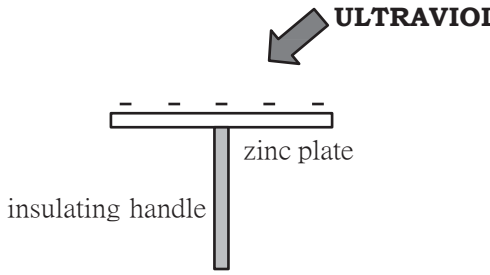
B



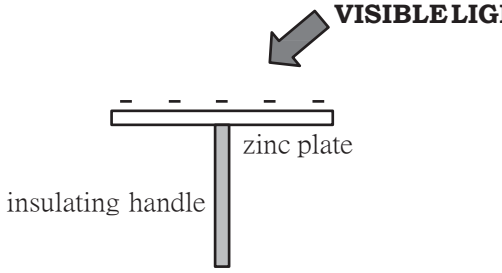
C



D



E



16. Electromagnetic radiation of frequency $9{\cdot}0 \times 10^{14}$ Hz is incident on a clean metal surface.

The work function of the metal is $5{\cdot}0 \times 10^{-19}$ J.

The maximum kinetic energy of a photoelectron released from the metal surface is

A $1{\cdot}0 \times 10^{-19}$ J

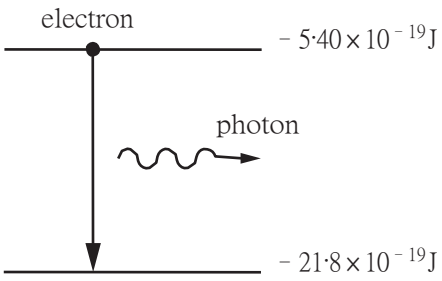
B $4{\cdot}0 \times 10^{-19}$ J

C $5{\cdot}0 \times 10^{-19}$ J

D $6{\cdot}0 \times 10^{-19}$ J

E $9{\cdot}0 \times 10^{-19}$ J.

17. In an atom, a photon of radiation is emitted when an electron makes a transition from a higher energy level to a lower energy level as shown.



The wavelength of the radiation emitted due to an electron transition between the two energy levels shown is

A $1{\cdot}2 \times 10^{-7}$ m

B $7{\cdot}3 \times 10^{-8}$ m

C $8{\cdot}2 \times 10^{6}$ m

D $1{\cdot}4 \times 10^{7}$ m

E $2{\cdot}5 \times 10^{15}$ m.

[Turn over

18. Which of the following statements describes a spontaneous nuclear fission reaction?

A $^{235}_{92}U + ^{1}_{0}n \rightarrow ^{144}_{56}Ba + ^{90}_{36}Kr + 2\,^{1}_{0}n$

B $^{7}_{3}Li + ^{1}_{1}H \rightarrow ^{4}_{2}He + ^{4}_{2}He$

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

D $^{226}_{88}Ra \rightarrow ^{222}_{86}Rn + ^{4}_{2}He$

E $^{216}_{84}Po \rightarrow ^{216}_{84}Po + \gamma$

19. The statement below represents a nuclear reaction.

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

20. A source of gamma radiation is stored in a large container. A count rate of 160 counts per minute, after correction for background radiation, is recorded outside the container.

The container is to be shielded so that the corrected count rate at the same point outside the container is no more than 10 counts per minute.

Lead and water are available as shielding materials. For this source, the half-value thickness of lead is 11 mm and the half-value thickness of water is 110 mm.

Which of the following shielding arrangements meets the above requirements?

A 40 mm of lead only

B 33 mm of lead plus 110 mm of water

C 20 mm of lead plus 220 mm of water

D 11 mm of lead plus 275 mm of water

E 10 mm of lead plus 330 mm of water

2 0

The total mass on the left hand side is $8{\cdot}347 \times 10^{-27}$kg.

The total mass on the right hand side is $8{\cdot}316 \times 10^{-27}$kg.

The energy released during one nuclear reaction of this type is

A $9{\cdot}30 \times 10^{-21}$ J

B $2{\cdot}79 \times 10^{-12}$ J

C $7{\cdot}51 \times 10^{-10}$ J

D $1{\cdot}50 \times 10^{-9}$J

E $2{\cdot}79 \times 10^{15}$J.