

X069/12/02

NATIONAL
QUALIFICATIONS
2013

MONDAY, 27 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 significant figures in the final 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.

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DATA SHEET
COMMON PHYSICAL QUANTITIES

Quantity	Symbol	Value	Quantity	Symbol	Value
Speed of light in vacuum	c	$3.00 \times 10^8 \text{ m s}^{-1}$	Mass of electron	m_e	$9.11 \times 10^{-31} \text{ kg}$
Magnitude of the charge on an electron	e	$1.60 \times 10^{-19} \text{ C}$	Mass of neutron	m_n	$1.675 \times 10^{-27} \text{ kg}$
Gravitational acceleration on Earth	g	9.8 m s^{-2}	Mass of proton	m_p	$1.673 \times 10^{-27} \text{ kg}$
Planck's constant	h	$6.63 \times 10^{-34} \text{ J s}$			

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	Element	Wavelength/nm	Colour
Hydrogen	656	Red	Cadmium	644	Red
	486	Blue-green		509	Green
	434	Blue-violet		480	Blue
	410	Violet	<i>Lasers</i>		
	397	Ultraviolet			
	389	Ultraviolet	<i>Element</i>	<i>Wavelength/nm</i>	<i>Colour</i>
Sodium	589	Yellow	Carbon dioxide	9550	Infrared
			Helium-neon	633	Red

PROPERTIES OF SELECTED MATERIALS

Substance	Density/kg m ⁻³	Melting Point/K	Boiling Point/K
Aluminium	2.70×10^3	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 $1.01 \times 10^5 \text{ Pa}$.

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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).

	A	B	C	D	E
	—	—	—	—	—

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**.

A	B	C	D	E	
—	—	—	—	—	

[Turn over

SECTION A

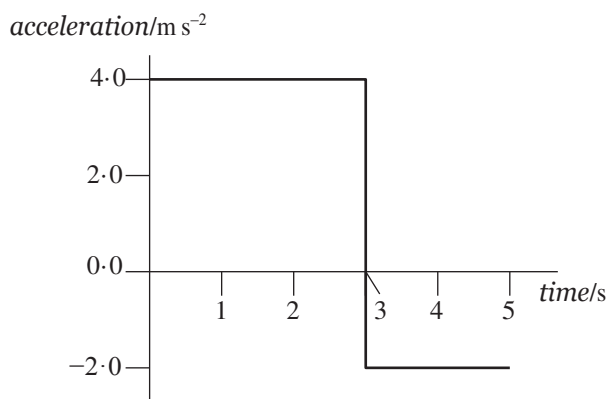
Answer questions 1–20 on the answer sheet.

1. Which of the following is a vector quantity?

- A distance
- B time
- C speed
- D energy
- E weight

2. An object starts from rest and accelerates in a straight line.

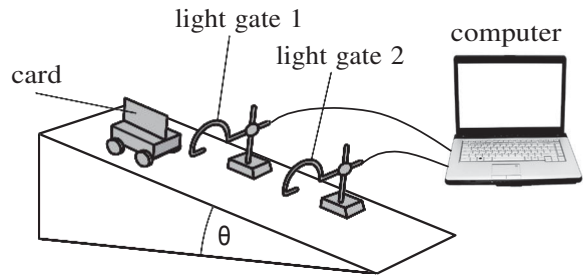
The graph shows how the acceleration of the object varies with time.



The speed of the object at 5 seconds is

- A 2 m s^{-1}
- B 8 m s^{-1}
- C 12 m s^{-1}
- D 16 m s^{-1}
- E 20 m s^{-1} .

3. A vehicle runs down a slope as shown.



The following results are obtained.

angle of slope,

$$\theta = 15.0 \pm 0.5^\circ$$

length of card on top of vehicle,

$$d = 0.020 \pm 0.001 \text{ m}$$

time for card to pass light gate 1,

$$t_1 = 0.40 \pm 0.01 \text{ s}$$

time for card to pass light gate 2,

$$t_2 = 0.25 \pm 0.01 \text{ s}$$

time for vehicle to travel between the light gates,

$$t_3 = 0.50 \pm 0.01 \text{ s}$$

Which quantity has the largest percentage uncertainty?

- A θ
- B d
- C t_1
- D t_2
- E t_3

4. Two blocks are linked by a newton balance of negligible mass.

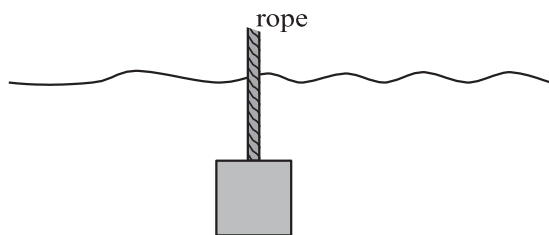
The blocks are placed on a level, frictionless surface. A force of 18.0 N is applied to the blocks as shown.



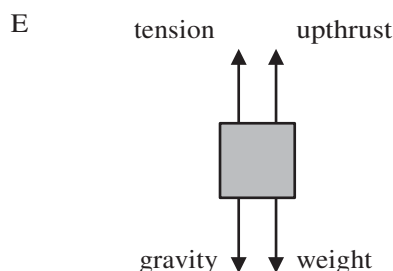
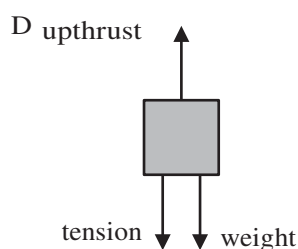
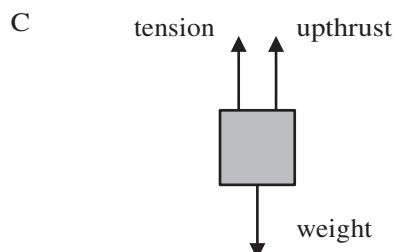
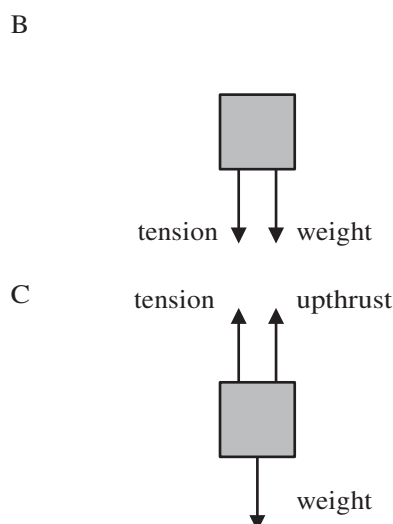
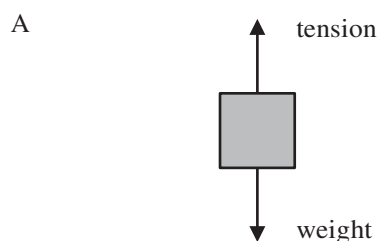
The reading on the newton balance is

- A 7.2 N
- B 9.0 N
- C 10.8 N
- D 18.0 N
- E 40.0 N .

5. A box is suspended by a rope under the surface of the sea.



Which diagram shows the vertical forces acting on the box?



6. A cannon of mass 2.0×10^3 kg fires a cannonball of mass 5.00 kg.

The cannonball leaves the cannon with a speed of 50.0 m s^{-1} .

The speed of the cannon immediately after firing is

- A 0.125 m s^{-1}
 B 8.00 m s^{-1}
 C 39.9 m s^{-1}
 D 40.1 m s^{-1}
 E 200 m s^{-1} .

7. The pressure of a gas in a sealed syringe is 1.5×10^5 Pa.

The temperature of the gas is 27°C .

The temperature of the gas is now raised by 10°C and the volume of the gas halved.

The new pressure of the gas in the syringe is

- A 1.1×10^5 Pa
 B 2.8×10^5 Pa
 C 3.1×10^5 Pa
 D 4.1×10^5 Pa
 E 11×10^5 Pa.

8. A student writes the following statements about electric fields.

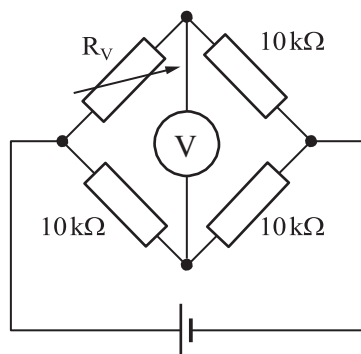
- I There is a force on a charge in an electric field.
 II When an electric field is applied to a conductor, the free electric charges in the conductor move.
 III Work is done when a charge is moved in an electric field.

Which of the statements is/are correct?

- A I only
 B II only
 C I and II only
 D I and III only
 E I, II and III

[Turn over]

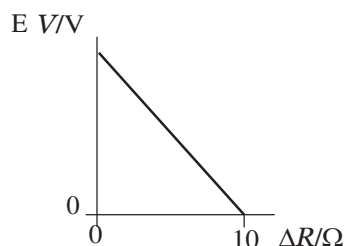
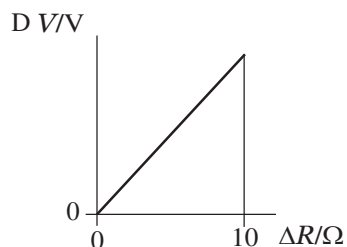
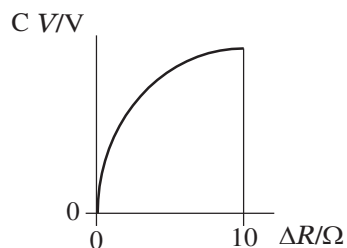
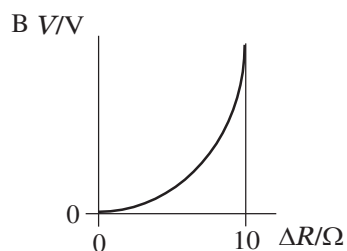
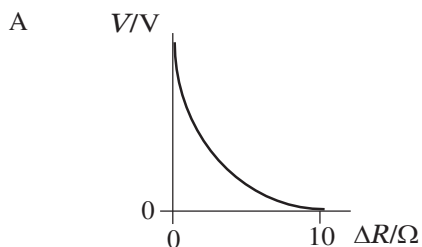
9. The diagram shows a Wheatstone bridge.



The reading on the voltmeter is zero.

The variable resistor R_V is now altered in steps of $1\ \Omega$ and each corresponding reading on the voltmeter is noted.

Which of the following graphs shows how the reading on the voltmeter, V , varies with the change in resistance ΔR ?



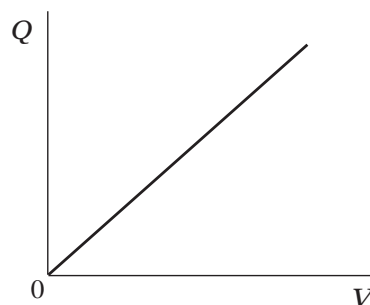
10. The capacitance of a capacitor is $1000\ \mu\text{F}$. The potential difference (p.d.) across the capacitor is $100\ \text{V}$. The charge stored by the capacitor is $0.10\ \text{C}$.

The charge on the capacitor is now reduced to half its original value.

Which row in the table shows the capacitance of the capacitor and the p.d. across the capacitor, for this new value of charge?

	Capacitance/ μF	p.d./V
A	1000	200
B	500	100
C	1000	100
D	500	50
E	1000	50

11. The graph shows how the charge, Q , stored on a capacitor varies with the potential difference, V , across the capacitor.

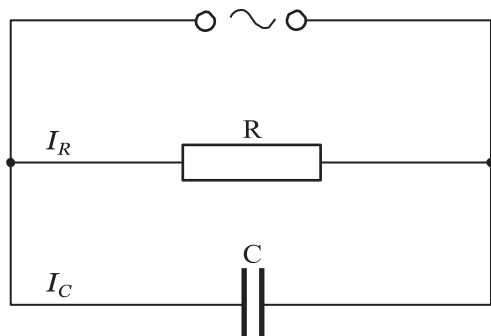


Which of the following statements is/are correct?

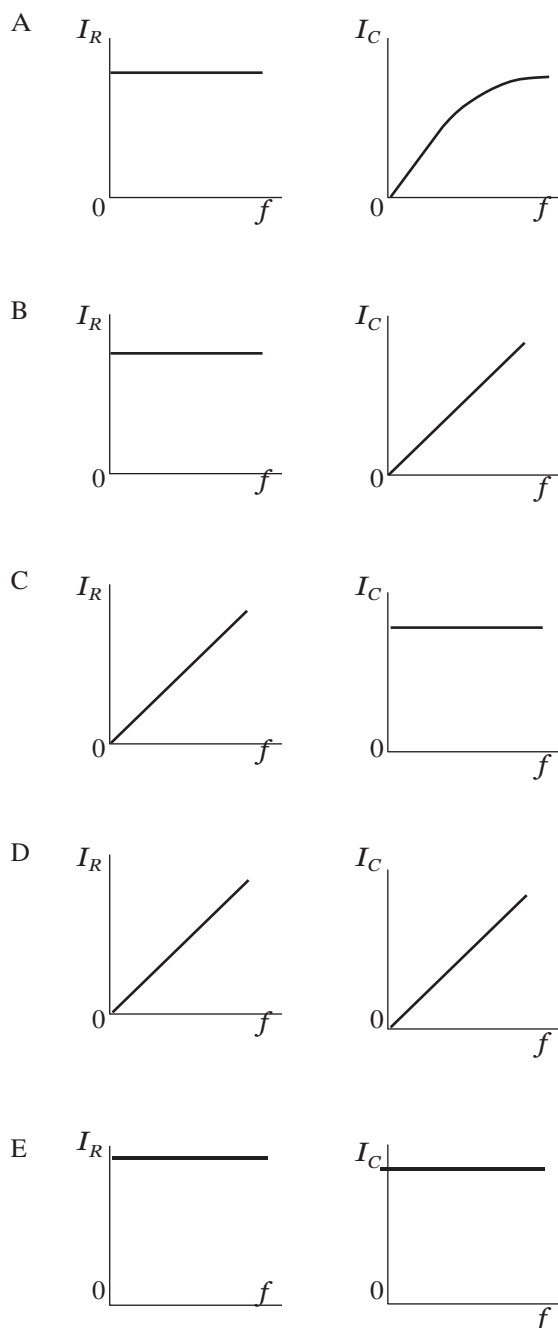
- I The gradient of the graph represents the capacitance of the capacitor.
- II The area under the graph represents the work done in charging the capacitor.
- III The energy, E , stored in the capacitor is given by the equation $E = QV$.

- A I only
- B II only
- C III only
- D I and II only
- E I, II and III

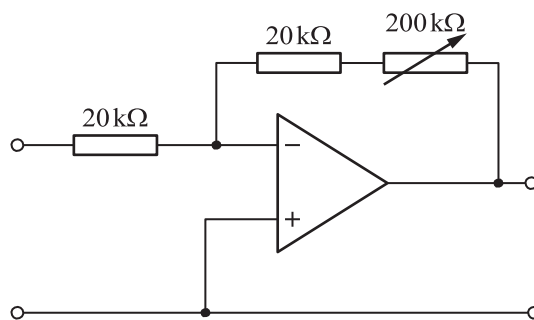
12. The following circuit shows a constant voltage a.c. supply connected to a resistor and capacitor in parallel.



Which pair of graphs shows how the r.m.s. currents I_R and I_C vary as the frequency, f , of the supply is increased?



13. A physicist designs the amplifier circuit shown.



In this circuit, adjustment of the resistance of the variable resistor from zero to $200\text{ k}\Omega$ allows the voltage gain to be altered over the range

- A zero to one
B zero to ten
C zero to eleven
D one to ten
E one to eleven.
14. The energy of a water wave depends on its
- A amplitude
B period
C phase
D speed
E wavelength.
15. Light travels from air into glass.

Which row in the table describes what happens to the speed, frequency and wavelength of the light?

	<i>Speed</i>	<i>Frequency</i>	<i>Wavelength</i>
A	increases	decreases	stays constant
B	decreases	stays constant	decreases
C	stays constant	decreases	decreases
D	increases	stays constant	increases
E	decreases	decreases	stays constant

16. The irradiance of light can be measured in

- A W
- B W m^{-1}
- C W m
- D W m^{-2}
- E W m^2 .

17. Ultraviolet radiation causes the emission of photoelectrons from a zinc plate.

The irradiance of the ultraviolet radiation on the zinc plate is increased.

Which row in the table shows the effect of this change?

	<i>Maximum kinetic energy of a photoelectron</i>	<i>Number of photoelectrons emitted per second</i>
A	increases	no change
B	no change	increases
C	no change	no change
D	increases	increases
E	decreases	increases

18. A student reads the following passage in a physics dictionary.

“... is a solid state device in which positive and negative charge carriers are produced by the action of light on a p-n junction.”

The passage describes

- A a thermistor
- B a MOSFET
- C a photodiode
- D a laser
- E an LED.

19. A student makes the following statements about Rutherford’s model of the atom.

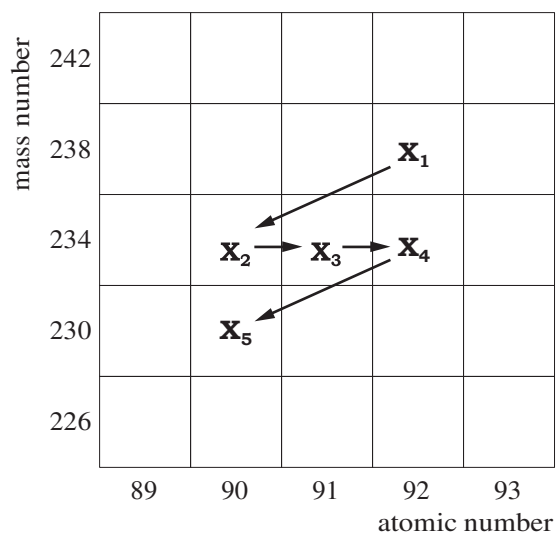
- I The nucleus has a relatively small diameter compared with that of the atom.
- II Most of the mass of the atom is concentrated in the nucleus.
- III The nucleus consists of positive and negative charges.

Which of these statements is/are correct?

- A I only
- B II only
- C III only
- D I and II only
- E I, II and III

20. Part of a radioactive decay series is shown in the diagram.

The symbols \mathbf{X}_1 to \mathbf{X}_5 represent nuclides in this series.



A student makes the following statements about the decay series.

- I Nuclides \mathbf{X}_2 and \mathbf{X}_3 contain the same number of protons.
- II Nuclide \mathbf{X}_1 decays into nuclide \mathbf{X}_2 by emitting an alpha particle.
- III Nuclide \mathbf{X}_3 decays into nuclide \mathbf{X}_4 by emitting a beta particle.

Which of these statements is/are correct?

- A I only
- B II only
- C III only
- D II and III only
- E I, II and III

