

Wednesday 1 December 2021 – Afternoon

**GCSE (9–1) Combined Science (Physics) A
(Gateway Science)**

J250/12 Paper 12 (Higher Tier)

Time allowed: 1 hour 10 minutes



You must have:

- a ruler (cm/mm)
- the Data Sheet for GCSE (9–1) Combined Science (Physics) A (inside this document)

You can use:

- a scientific or graphical calculator
- an HB pencil



Please write clearly in black ink. **Do not write in the barcodes.**

Centre number

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Candidate number

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First name(s)

Last name

INSTRUCTIONS

- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

INFORMATION

- The total mark for this paper is **60**.
- The marks for each question are shown in brackets [].
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document has **20** pages.

ADVICE

- Read each question carefully before you start your answer.

2
SECTION A

Answer **all** the questions.

You should spend a maximum of 20 minutes on this section.

Write your answer to each question in the box provided.

- 1** Which row in the table explains why a safety belt is a safety feature in a car?

	Deceleration of driver	Force on driver
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

Your answer

[1]

- 2** Which factor increases **both** thinking distance **and** braking distance?

- A** Drinking alcohol
- B** Icy roads
- C** Increasing speed
- D** Worn tyres

Your answer

[1]

- 3 Some waves are transverse. Some waves are longitudinal.

Which row in the table is correct?

	Transverse	Longitudinal
A	light	sound
B	sound	light
C	sound	water ripples
D	water ripples	light

Your answer

[1]

- 4 An atom of element **X** can be written like this:



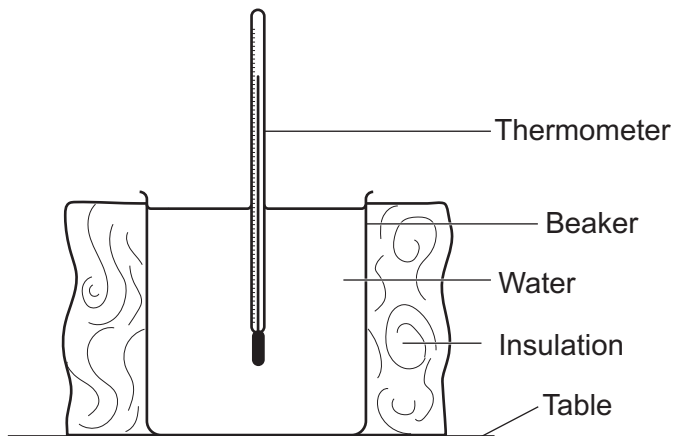
What does an atom of element **X** contain?

- A** 11 protons, 9 neutrons and 11 electrons
- B** 11 protons, 11 neutrons and 11 electrons
- C** 20 protons, 11 neutrons and 9 electrons
- D** 20 protons, 11 neutrons and 20 electrons

Your answer

[1]

- 5 A student investigates how hot water in an insulated beaker cools. They test how the thickness of insulation affects the rate of cooling.



Which row in the table describes a valid procedure?

	What the student keeps the same	What the student changes	What the student measures
A	starting temperature	thickness of insulation	temperature rise of water
B	starting temperature	thickness of insulation	temperature drop of water
C	volume of water	starting temperature	thickness of insulation
D	volume of water	temperature of water	thickness of insulation

Your answer

[1]

- 6 Which property is the same for all electromagnetic waves in space?

- A** Frequency
- B** Time period
- C** Velocity
- D** Wavelength

Your answer

[1]

- 7 The speed of sound is greater than the speed of a person walking.

Estimate how many times greater.

- A 10^2
- B 10^4
- C 10^6
- D 10^8

Your answer

[1]

- 8 A 6 V battery transfers 1860 J of energy.

Calculate the charge transferred by the battery.

Use the equation: energy transferred = charge $\times$ potential difference

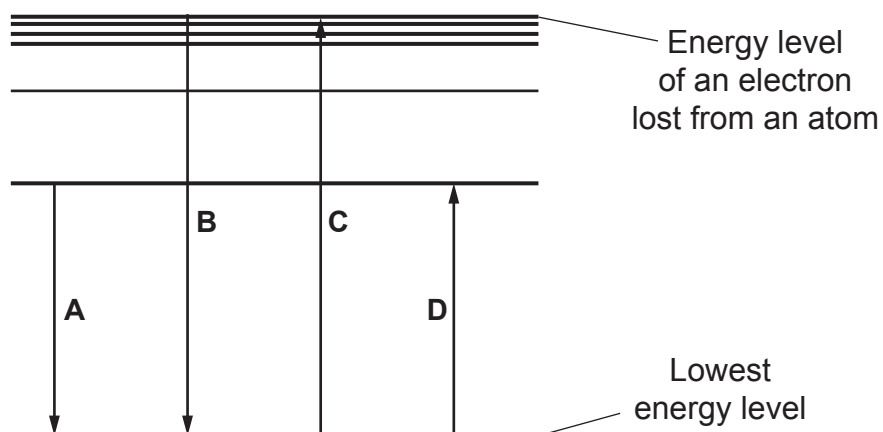
- A 0.31 C
- B 11.16 C
- C 310 C
- D 11 160 C

Your answer

[1]

- 9 This is a model of energy levels inside a hydrogen atom.

The arrows shown as $\uparrow$ and $\downarrow$ represent an electron moving between energy levels.



Which electron movement, **A**, **B**, **C** or **D**, shows ionisation?

Your answer

[1]

- 10 An 800 W microwave oven is used for 30 minutes.

What is the energy transferred in kWh?

Use the equation: energy transferred = power $\times$ time

- A** 0.4 kWh
- B** 24 kWh
- C** 240 kWh
- D** 400 kWh

Your answer

[1]

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SECTION B

Answer **all** the questions.

11 (a) Radio waves are electromagnetic waves and are used for communications.

(i) Suggest why gamma rays are **not** used for communications.

.....
 [1]

(ii) Name **one** other electromagnetic wave that is used for communications.

..... [1]

(iii) State **one** use of this electromagnetic wave in communications.

..... [1]

(b) A TV transmitter emits electromagnetic waves with different frequencies.

Table 11.1 gives information about the waves emitted.

Name of wave	Frequency (MHz)	Wavelength (m)	Energy (10^{-18} J)
BBC A	562	0.533	3.72
ARQ A	571	0.526	3.78
D3&4	578	0.519	3.83
BBC B	586	0.511	3.88
ARQ B	594	0.505	3.94
SDN	691	0.435	4.57

Table 11.1

- (i) Using data from **Table 11.1** describe the relationship between **frequency** and **wavelength**.

.....
 [2]

- (ii) How many significant figures are used in each value in **Table 11.1**?

..... [1]

- (iii) Calculate the speed of the wave **ARQ B**.

Use the equation: wave speed = frequency $\times$ wavelength

Speed = ... m/s [3]

- (c) A TV transmitter has a useful output energy transfer of 100 kJ in 1 second.

The input energy is 250 kJ in 1 second.

Calculate the efficiency of the TV transmitter.

Efficiency = ... [3]

12* Two students do an experiment to calculate their reaction times. They use a 30 cm ruler.

Describe, in detail, a suitable method the students can use to calculate reaction time using the ruler.

In your answer, include:

- Equations the students can use to calculate reaction time.
- How the students can obtain accurate and precise results.

..... [6

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13 (a) State the law of conservation of energy.

.....

.....

.....

..... [2]

(b) Fig. 13.1 shows the experiment a student sets up on the ground to investigate energy stores.

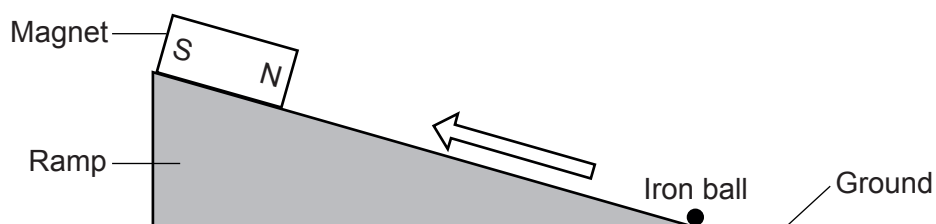


Fig. 13.1

- The student places a magnet at the top of a small ramp.
- They place a small iron ball at the bottom of the ramp.
- The iron ball is attracted up the ramp.
- The iron ball 'sticks' to the magnet.

The table describes how the energy stores change.

Complete the table using the words **MAXIMUM** and **MINIMUM**.

Type of store	At the bottom of the ramp	At the top of the ramp
Magnetic energy store		
Gravitational energy store		
Thermal energy store		

[4]

- (c) The magnet and iron ball are removed. A marble is instead rolled down the ramp, as shown in Fig. 13.2.

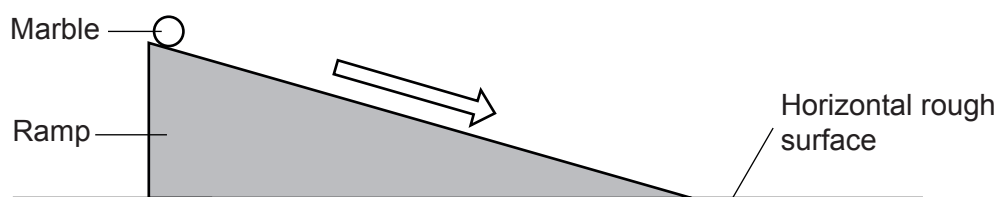


Fig. 13.2

- (i) The mass of the marble is 0.003 kg.

The kinetic energy of the marble is 0.024 J at the bottom of the ramp.

Calculate the speed of the marble at the bottom of the ramp.

Use the equation: kinetic energy = $0.5 \times \text{mass} \times (\text{speed})^2$

Speed = ... m/s [3]

- (ii) The marble rolls to a stop on the horizontal rough surface after it leaves the ramp.

Explain what happens to the kinetic energy store of the marble.

.....

 [2]

14 **X** and **Y** are radioactive isotopes. They emit either alpha particles or beta particles.

- (a) Complete **Table 14.1** to show what happens to a **nucleus** of an atom when an alpha particle or a beta particle is emitted.

	Alpha particle emitted	Beta particle emitted
Change in mass of nucleus		0
Change in charge on nucleus	-2	

Table 14.1

[2]

- (b) A scientist measures the half-life of isotope **X**.

They measure the half-life **three** times.

Why do they get a slightly different result each time?

.....
 [1]

- (c) After 18 days, the ratio of the activity of **X** to the initial activity of **X** is 1:4.

Calculate the half-life of isotope **X**.

Half-life = ...days [2]

- (d) Isotope **X** only gives out beta particles. Isotope **Y** only gives out alpha particles.

The scientist measures the activity of **one** of the isotopes using a Geiger counter.

They then place a material between the isotope and the Geiger counter and record the reading.

Table 14.2 shows their results:

Material between isotope and Geiger counter	Reading on Geiger counter (Bq)
Paper	No change
Aluminium sheet	Decreases

Table 14.2

Which isotope are they using?

Give **two** reasons for your answer.

Isotope:

1

.....

2

.....

[2]

- (e) The scientist accidentally places isotope **X** close to isotope **Y**.

Explain why isotope **Y** is irradiated, but **not** contaminated, by isotope **X**.

.....

.....

.....

..... [2]

- (f) Nuclear power is non-renewable and the plants can produce nuclear waste.

Suggest **two** reasons why some countries still use nuclear power.

1

.....

2

.....

[2]

15 Two students are making waves using a dripping tap.

The water droplets create waves in the water in a bowl.



(a) Describe the change in energy stores as a water droplet

- falls from the tap:
- lands in the water in the bowl: [2]

(b) The students count the number of droplets hitting the water in the bowl.

In 20 seconds, 5 droplets hit the water in the bowl.

Calculate the frequency of the waves produced.

Frequency = ... Hz [2]

(c) How can the students tell that the water waves travel but the water does not?

.....

..... [1]

- (d) (i) One of the students says, 'the temperature of the water in the bowl increases when the water drips into it'.

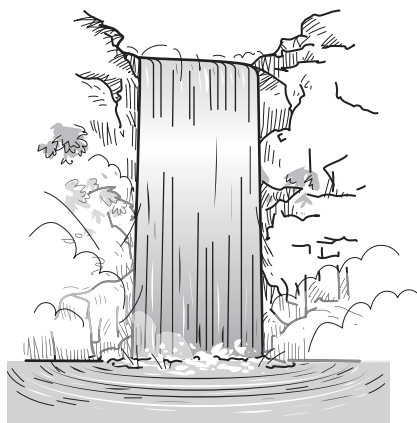
- 1 droplet of water transfers 5.04×10^{-4} J of energy as it lands in the bowl.
- The bowl contains 3 kg of water.
- The specific heat capacity of water is $4200 \text{ J/kg } ^\circ\text{C}$.

Calculate the temperature rise of the water in the bowl when 1 droplet of water lands in it.

Use an equation from the Data Sheet to help you.

Temperature rise = ... $^\circ\text{C}$ [3]

- (ii) In 1847, James Joule did experiments at the bottom of a waterfall.



He was unable to measure the temperature rise of the water.

Suggest **two** reasons why.

- 1
-
- 2
-

[2]

END OF QUESTION PAPER

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