Modified Enlarged 18pt

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Thursday 9 June 2022 – Afternoon

GCSE (9–1) Physics B
(Twenty First Century Science)

J259/01 Breadth in physics (Foundation Tier)

Time allowed: 1 hour 45 minutes
plus your additional time allowance

YOU MUST HAVE:
a ruler (cm/mm)
the Data Sheet for GCSE (9–1) Physics B
(with this document)

YOU CAN USE:
a scientific or graphical calculator
an HB pencil

Please write clearly in black ink.

Centre number | | | | | |

Candidate number | | | | |

First name(s) _____

Last name _____

READ INSTRUCTIONS OVERLEAF

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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 answers should be supported with working. Marks might be given for using a correct method, even if the answer is wrong.

INFORMATION

The total mark for this paper is 90.

The marks for each question are shown in brackets [ ].

ADVICE

Read each question carefully before you start your answer.

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Answer ALL the questions.

1 Layla uses a motor to lift a weight, as shown in the diagram. The motor is powered by a battery.

(a) (i) What is the energy store of the battery?

Tick (✓) ONE box. [1]

- Chemical ☐
- Electrical ☐
- Nuclear ☐
- Thermal ☐

(ii) How is energy transferred from the battery to the motor?

Tick (✓) ONE box. [1]

- By heating ☐
- By radiation ☐
- Electrically ☐
- Mechanically ☐

(b) (i) Layla measures the power of the motor as 13 W.

It takes 3.0 s to lift the weight.

Calculate the energy transferred by the motor.

Use the equation:
energy transferred = power × time

Energy = _____ J [2]

(ii) Layla repeats the experiment.

She measures the power three times in total.

Her three measurements are:
13 W 17 W 12 W

Calculate the mean (average) power.

Mean power = _____ W [2]

(c) Layla's teacher says that the motor transfers too much energy to thermal energy.

How could Layla reduce this unwanted energy transfer?

Tick (✓) ONE box. [1]

Use a higher voltage battery. ☐

Use foam to insulate the motor. ☐

Use longer wires. ☐

Use oil to lubricate the motor. ☐

2 **Amir is studying the structure of atoms. FIG. 2.1 shows a model of an atom.**

FIG. 2.1

(a) (i) Use a word from the list to complete the sentence.

ELECTRONS NEUTRONS PROTONS

The atom has a positive nucleus surrounded

by negative _____ [1]

(ii) Use words from this list to complete the sentence.

CHARGE MASS NUCLEUS

SPACE VOLUME

Almost all of the _____ of the atom

is in the _____ [2]

(b) What is the typical size of an atom?

Tick (✓) ONE box. [1]

10^{10} m	☐
10^{5} m	☐
10^{-5} m	☐
10^{-10} m	☐

(c) Amir researches the hydrogen atom. He finds diagrams of three different hydrogen atoms. The diagrams are shown in FIG. 2.2.

FIG. 2.2

Amir says 'They have the same number of protons, but a different number of neutrons.'

(i) **Which statement could be used to describe these atoms?**

Tick (✓) ONE box. [1]

- **They are identical** ☐
- **They are isotopes** ☐
- **They are negative ions** ☐
- **They are positive ions** ☐

(ii) **One of the atoms is unstable.**

Which statement can be used to describe this atom?

Tick (✓) ONE box. [1]

- **The neutrons are positively charged.** ☐
- **The nucleus may emit a radioactive particle.** ☐
- **The proton orbits the nucleus.** ☐
- **There are electrons in the nucleus.** ☐

3 **Beth investigates the pressure and volume of gases.**

She uses the equipment shown in the diagram.

The pressure of the gas is increased by using a greater weight of books.

(a) **The pressure of the gas causes forces against the inside surface of the syringe.**

Which statement correctly describes the direction of these forces?

Tick (✓) ONE box. [1]

They act at right angles to the surface of the syringe. ☐

They all act downwards. ☐

They act in random directions. ☐

They act parallel to the surface of the syringe. ☐

(b) Beth wants to increase the force from the books by 24 N.

(i) Calculate the mass of a book with a weight of 24 N.

Gravitational field strength = 10 N / kg

Use the equation:
mass = weight ÷ gravitational field strength

Mass = _____ kg [2]

(ii) The surface area of the top of the syringe is $0.0012\,m^2$.

Beth adds a book with a weight of 24 N.

Calculate the increase in pressure.

Use the equation:
pressure = force normal to a surface
÷ area of that surface

Pressure = _____ Pa [2]

(c) The temperature of the gas remains constant.

Beth observes that as the pressure increases, volume decreases.

Which statements correctly explain why this happens?

Tick (✓) TWO boxes. [2]

- [ ] The particles are closer together.
- [ ] The particles become smaller.
- [ ] The particles collide more often.
- [ ] The particles move faster.
- [ ] The particles push with a larger force when they collide.

4 **Kai investigates how the strength of a magnet depends on distance from the magnet.**

He uses the equipment shown in the diagram. The distance between the magnet and the paperclips is varied by using different numbers of sheets of paper.

(a) (i) Complete the following sentences about the paperclips.

Use words from the list.

copper	**hard**	**induced**
iron	**permanent**	**zinc**

When the magnet is close to the paperclips

they become _____ magnets.

They must be made of a magnetic material,

such as _____ . [2]

(ii) Describe the difference between a permanent and an induced magnet.

_____

_____ [1]

(b) Kai's results are shown in the table.

Number of sheets of paper	Number of paperclips attracted to magnet			
	1	2	3	Mean
1	9	6	10	8.3
2	5	7	11	7.7
3	5	5	8	6.0
4	3	4	7	4.7
5	3	6	2	3.7
6	2	5	3	3.3

(i) Kai evaluates the quality of his data in the table.

Kai says 'I don't think that my data is precise.'

Explain why Kai is correct.

_____

_____

_____ [1]

(ii) Describe the pattern in Kai's data.

_____

_____

_____ [1]

(c) Kai decides to investigate the strength of electromagnets.

He builds an electromagnet by wrapping a coil of wire around an iron core.

How could Kai increase the strength of his electromagnet?

Tick (✓) ONE box. [1]

Swap the iron core for a plastic core. ☐

Increase the current in the wires. ☐

Increase the resistance of the wires. ☐

Increase the spacing between the coils. ☐

5 **Eve investigates how white light reflects from a mirror.**

FIG. 5.1 shows her equipment.

FIG. 5.1

(a) What is the name of the dotted line P in FIG. 5.1?

Tick (✓) ONE box. [1]

Boundary line	☐
Incident ray	☐
Normal line	☐
Reflected ray	☐

(b) Eve records the position of the ray by marking crosses on the paper and then joining them together.

Describe two things that Eve should do to record the position as accurately as possible.

1 _____

_____

2 _____

_____

[2]

(c) FIG. 5.2 shows the expected result from Eve's investigation.

FIG. 5.2

Write the letter (A, B, C or D) of the correct diagram. _____ [1]

(d) **Eve wants to extend her experiment.**

Eve says 'White light is a mixture of different wavelengths.

I want to investigate the reflection of just one wavelength of light.'

Suggest how Eve could extend her experiment to investigate just one wavelength of light.

_____

_____

_____

_____ **[2]**

6 **Ben uses a battery-powered shaver.**

The shaver uses an electric motor to move the blades.

A circuit diagram for the shaver is shown below.

(a) When the shaver is switched on, energy is transferred.

Which TWO statements correctly describe changes in the energy stores when the shaver is switched on?

Tick (✓) TWO boxes. [2]

Chemical energy store in battery decreases. ☐

Elastic energy store in room increases. ☐

Gravitational energy store in battery decreases. ☐

Kinetic energy store in battery decreases. ☐

Nuclear energy store in room increases. ☐

Thermal energy store in room increases. ☐

(b) The potential difference of the battery is 1.2 V.

(i) Each time Ben uses the shaver, 180 C of charge flows.

Calculate the energy transferred each time he uses the shaver.

Use the equation:
energy transferred =
charge flow × potential difference

Energy transferred = _____ J [2]

(ii) The power of the shaver is 1.1 W.

Calculate the current flowing through the shaver.

Use the equation:
power = potential difference × current

Give your answer to 2 significant figures.

Current = _____ A [3]

7 FIG. 7.1 shows a hole puncher.

FIG. 7.1

The lever is pushed down to punch a hole in some paper.

FIG. 7.2 shows two of the forces on the lever when it has been pushed down. The force arrows P and Q have not been drawn to scale.

FIG. 7.2

(a) The size of force P is 30 N.

The distance from the pivot to force P is 6.0 cm.

Calculate the moment of the force.

Use the equation:
moment of a force = force × distance
(normal to direction of the force)

Moment = _____ Nm [3]

(b) (i) **The force Q is caused by the metal cylinder pushing against the lever.**

Which statement describes how to increase Q without increasing P?

Tick (✓) ONE box. [1]

- [ ] **Push closer to the pivot.**
- [ ] **Push further from the pivot.**
- [ ] **Push sideways instead of down.**
- [ ] **Push up instead of down.**

(ii) **The lever exerts a force R on the metal cylinder. The force R and force Q are an interaction pair.**

Compare and contrast force P to the force Q.

_____

_____ **[2]**

(c) **Explain how the lever returns to its original position when P is removed.**

_____

_____

_____ **[1]**

8 **Jack is a sprinter. He uses a parachute when he trains, as shown in FIG. 8.1.**

FIG. 8.1

(a) **FIG. 8.2 shows the forces acting on Jack when he is training.**

FIG. 8.2

(i) Name the upwards and downwards forces acting on Jack.

Upwards force _____

Downwards force _____

[2]

(ii) Jack's mass is 60 kg.

Calculate Jack's acceleration.

Use information from FIG. 8.2.

Use the equation: acceleration = force ÷ mass

Acceleration = _____ m/s^2 [3]

(b) FIG. 8.3 shows the horizontal forces acting on Jack a few moments later. Jack is still running.

FIG. 8.3

Describe Jack's velocity, and explain your answer using information from FIG. 8.3.

_____

_____

_____

_____ [2]

(c) Jack wants to buy a new training parachute.
He wants a parachute that will give the biggest possible air resistance.

The table shows information about three parachutes.

Parachute	Diameter (cm)	Mass (kg)	Cost
A	42	0.32	£9
B	48	0.29	£15
C	56	0.30	£12

Suggest which parachute Jack should buy.

_____

_____

_____ [2]

9 **Jane investigates how the resistance of a wire depends on its diameter.**

She uses the circuit shown in the diagram to measure the resistance of wires of different diameters.

(a) One control variable in this experiment is the temperature of the wire.

(i) Suggest how to keep the temperature of the wire constant.

_____

_____ **[1]**

(ii) State TWO other control variables for this experiment.

1 _____

_____

2 _____

_____

[2]

(b) Jane makes the following measurements for one wire.

reading on voltmeter = 0.55 V
reading on ammeter = 2.5 A

Use the Data Sheet.
Calculate the resistance of the wire.

Resistance = _____ Ω [3]

(c) The table and graph show Jane's results.

diameter (mm)	resistance (Ω)
0.19	0.57
0.23	0.39
0.27	0.28
0.32	0.22
0.38	0.15
0.46	0.10

(i) **Complete the graph by plotting the missing result from the table and draw a line of best fit. [2]**

(ii) **Write a conclusion for Jane's investigation.**

_____

_____

_____

_____ **[2]**

10 Different types of wave can be used for communications.

Fifty years ago, microwaves were used for long distance communications. Microwaves travel through the air between microwave aerials.

Now, light waves travelling along optical fibres are normally used instead.

(a) State ONE similarity and ONE difference between microwaves and light waves.

Similarity _____

_____

Difference _____

_____

[2]

(b) The table compares the speed of the two methods of communication.

	Method of communication	Speed of wave (m/s)
1	Microwaves in air	3.0×10^8
2	Light waves in an optical fibre	2.0×10^8

(i) The distance between two locations is 90 km.

Use the Data Sheet.

Calculate the time taken for a light wave to travel this distance through an optical fibre.

Time = _____ s [4]

(ii) Li thinks about which method is better.

Li says 'Microwaves are better because the signals travel faster through the air.'

Evaluate Li's statement.

_____

_____ [1]

11 Nina investigates how the resistance of a thermistor depends on its temperature.

She controls the temperature of the thermistor by placing it in a beaker of water at different temperatures.

FIG. 11.1 shows part of her circuit diagram.

FIG. 11.1

(a) Complete FIG. 11.1 to include a thermistor correctly connected to the circuit. [1]

(b) TABLE 11.1 shows her data.

TABLE 11.1

Temperature (°C)	Resistance (Ω)
0	1300
80	1800

Nina says ‘My hypothesis is that as temperature increases, resistance increases.

To test this, I need a measurement at a temperature of about 50 °C.’

(i) Suggest how she could make water with a temperature of about 50 °C.

_____

_____ [1]

(ii) TABLE 11.2 shows her data including the measurement at 50 °C.

TABLE 11.2

Temperature (°C)	Resistance (Ω)
0	1300
50	350
80	1800

How will the new data affect Nina's confidence in her hypothesis?

Explain your answer.

Tick (✓) ONE box.

Less confident ☐

More confident ☐

No effect ☐

Explanation: _____

_____

_____ [2]

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(c) Nina made 7 more measurements at different temperatures.

All her data is plotted in FIG. 11.2.

FIG. 11.2

Describe the trend shown in FIG. 11.2.

_____

_____

_____

_____ **[2]**

12 Jamal, Sara and Jack are playing rounders.

Rounders is a game played with a bat and ball. FIG. 12.1 shows the layout of the pitch. The bowler stands at X and throws the ball towards the batter at Y.

The batter hits the ball and then tries to run to third base, from Y to Z.

FIG. 12.1

(a) Jamal hits the ball and runs along the path from Y to Z shown in FIG. 12.1.

Sara says 'The distance travelled by Jamal is different to his displacement.'

Explain why Sara is correct. Use information from FIG. 12.1 in your answer.

_____

_____

_____

_____ [2]

(b) Sara and Jack try to estimate how quickly Jamal speeded up.

Sara says 'He takes 10 seconds to reach a maximum speed of about 16 m/s.'

Jack says 'He takes 2.5 seconds to reach a maximum speed of about 4 m/s.'

(i) Which is the better estimate? Explain your answer.

Tick (✓) ONE box.

Sara ☐

Jack ☐

_____

_____ [1]

(ii) **Use EITHER estimate to calculate Jamal's acceleration.**

Use the Data Sheet.

Acceleration = _____ m/s^2 [3]

13 **Cancer can be treated using radiation. This is called radiotherapy.**

The diagram shows one way to use gamma rays to treat cancer.

(a) Describe why gamma rays can be used to treat cancer using the method shown in the diagram.

_____

_____

_____

_____

_____

_____

_____

_____

_____ **[3]**

(b) Ben's cancer is treated using gamma rays.

Ben says 'After the radiotherapy I will be contaminated with radiation.'

Explain why Ben is wrong.

_____

_____

_____ [2]

(c) X-rays can also be used for radiotherapy.

X-rays are produced electrically using a machine.

Suggest an advantage of treating cancer using X-rays instead of gamma rays.

_____

_____

_____ [1]

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

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