**chermistry.com**
Practice paper written from an analysis of every
O-Level Science (Physics) paper, 2010–2025

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|---|---|---|---|---|---|---|---|---|---|
| CANDIDATE NAME | | | | | | | | | |
| CENTRE NUMBER | S | | | | | INDEX NUMBER | | | | |

# SCIENCE (PHYSICS)

**Specimen**

Paper 2 Physics

PRACTICE PAPER · PAPER 2.3

**For practice before the next examination**

**1 hour 15 minutes**

Candidates answer on the Question Paper.

No Additional Materials are required.

This is a **chermistry practice paper**.

**READ THESE INSTRUCTIONS FIRST**

Write your name, centre number and index number in the boxes above.

You may use an HB pencil for any diagrams, graphs or rough working.

Write in dark blue or black pen.

Do not use staples, paper clips, glue or correction fluid.

The use of an approved scientific calculator is expected, where appropriate.

You may lose marks if you do not show your working or if you do not use appropriate units.

Take $g$ = 10 m/s$^2$ (or 10 N/kg) unless you are told otherwise.

**Section A**
Answer **all** questions.
Write your answers in the spaces provided on the question paper.

**Section B**
Answer **one** question.
Write your answers in the spaces provided on the question paper.

The number of marks is given in brackets [ ] at the end of each question or part question.

The total mark for this paper is 65.

This document consists of **21** printed pages.

**NOT AN OFFICIAL EXAMINATION PAPER**

Written for classroom practice from the topic frequencies in the chermistry theory-paper analysis. It follows the layout, wording and mark scheme conventions of the O-Level Science (Physics) papers but is not set, endorsed or marked by any examination board.

## Section A

Answer **all** the questions in the spaces provided.

**1** A train travels 40 km due east from station A to station B and then returns along the same straight track to station A.

**(a)** State the displacement of the train for the whole journey, and explain why this is different from the distance travelled.

.....

.....

..... [1]

**(b)** A maglev train floats above its track because of magnetic forces. If the power fails it settles on its wheels. Table 1.1 lists three forces. Complete Table 1.1 by writing **contact** or **non-contact** for each force.

**Table 1.1**

| force | contact or non-contact? |
|---|---|
| A the upward magnetic force of the track on the floating train | |
| B the upward push of the track on the wheels when the train rests on them | |
| C the gravitational pull of the Earth on the train | |

[2]

[Total: 3]

**2** A cargo aircraft carries a crate. The weight of the crate on Earth is 600 N. Take the gravitational field strength on Earth as 10 N/kg.

**(a)** The crate has weight. Explain, using the term *gravitational field*, why the crate has weight.

.....

.....

..... [2]

**(b)** Define gravitational field strength.

.....

..... [1]

**(c)** The crate is flown to the Moon, where its weight is 96 N. A student says: "The mass of the crate on the Moon is 9.6 kg, because 96 ÷ 10 = 9.6." Explain why the student is wrong, and state the mass of the crate on the Moon.

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..... [2]

[Total: 5]

**3** A locomotive of mass 40 000 kg pulls a wagon of mass 20 000 kg along a straight, level track. The locomotive and the wagon are joined by a coupling. The driving force on the locomotive is 24 000 N. The resistive forces are 4000 N on the locomotive and 2000 N on the wagon. The train accelerates at 0.30 $m/s^2$.

**(a)** Calculate the force exerted by the coupling on the wagon.

force = ..... N [2]

**(b)** When the rails are wet, the maximum braking force from friction between the wheels and the rails is 5000 N instead of 15 000 N when they are dry. Explain, in terms of the resultant force and the deceleration, why the train takes a longer distance to stop on wet rails.

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.....

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..... [2]

[Total: 4]

**4** Fig. 4.1 shows the barrier arm at a railway level crossing. It is held horizontal on a pivot by a counterweight *W*. The weight of the arm is 90 N and acts at the centre of the arm. A warning lamp of weight 20 N is fixed at the free end of the arm.

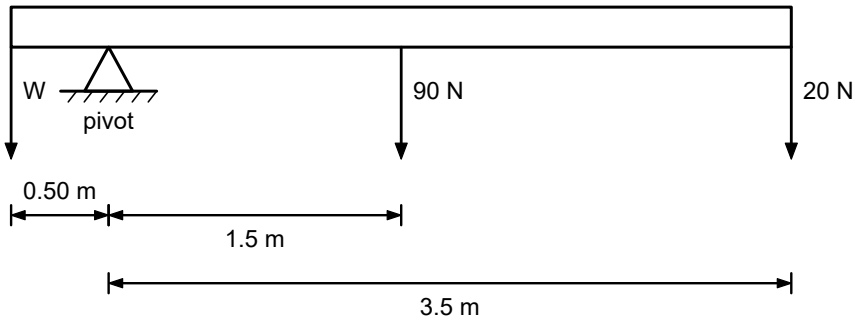



**Fig. 4.1**

**(a)** State the principle of moments.

.....

.....

..... [1]

**(b)** The arm is in equilibrium. Calculate the counterweight *W*.

*W* = ..... N [2]

[Total: 3]

**5** The brakes of a lorry of mass 12 000 kg fail on a downhill road. The lorry, travelling at 20 m/s, enters a rough gravel escape ramp that rises in a straight line. It comes to rest after rising through a vertical height of 15 m. Take $g$ = 10 N/kg.

**(a)** Use the principle of conservation of energy to calculate the energy transferred to the thermal store (as the lorry and ramp become warmer) by friction between the lorry and the ramp.

energy = ..... J [2]

**(b)** Before the brakes failed, the lorry travelled on a level road. Table 5.1 shows the total energy transferred by its engine, measured from the start of timing. Calculate the average power of the engine between 20 s and 50 s.

**Table 5.1**

| time / s | 0 | 20 | 35 | 50 |
|---|---|---|---|---|
| total energy transferred by the engine / $10^6$ J | 0 | 2.4 | 4.95 | 7.5 |

power = ..... W [2]

[Total: 4]

**6** The braking system of a car contains steel pipes, brake fluid and, after a fault, a few trapped air bubbles. Table 6.1 gives data about three of these materials, **P**, **Q** and **R**.

**(a)** Use Table 6.1 to deduce which of **P**, **Q** and **R** is the brake fluid, which is the air in a bubble and which is the steel of a pipe.

**Table 6.1**

| material | fixed shape? | fixed volume? | density / kg $m^{-3}$ |
|---|---|---|---|
| P | no | yes | 1050 |
| Q | no | no | 1.2 |
| R | yes | yes | 7800 |

brake fluid = .....

air in a bubble = .....

steel of a pipe = ..... [2]

**(b)** Compare the arrangement and the motion of the particles in the brake fluid with those in an air bubble. Use your comparison to explain why the air bubble can be compressed easily but the brake fluid cannot.

.....

.....

.....

.....

..... [2]

[Total: 4]

**7** A car is parked in strong sunshine.

**(a)** The metal door handle conducts energy much faster than a plastic handle of the same size would. Explain this, in terms of the particles in the metal.

.....

.....

..... [1]

**(b)** The air next to the hot dashboard is at 60 °C and has a density of 1.06 kg/m$^3$. The cooler air in the rest of the car is at 20 °C and has a density of 1.20 kg/m$^3$. Use these data to explain how a convection current is set up in the air inside the car.

.....

.....

.....

.....

..... [2]

**(c)** A black car and a white car of the same model are parked side by side.

**(i)** The energy from the Sun reaches the cars across space. Explain why this cannot be by conduction or by convection.

.....

..... [1]

**(ii)** After one hour the air inside the black car is at 52 °C and the air inside the white car is at 41 °C. Explain this difference.

.....

..... [1]

[Total: 5]

**8** A reversing sensor on a lorry sends out pulses of ultrasound towards obstacles behind the lorry.

**(a)** The sensor also has a buzzer that warns the driver. The buzzer is tested inside a sealed glass jar. As air is pumped out of the jar, the sound heard outside the jar gets fainter and finally cannot be heard, although the disc of the buzzer is still seen to vibrate. State what produces the sound, and explain why it can no longer be heard.

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.....

.....

..... [2]

**(b)** The ultrasound has a frequency of 40 kHz (40 000 Hz). Fig. 8.1 shows the displacement of the air particles at one instant along the path of a pulse. Use Fig. 8.1 to determine the speed of the ultrasound in air.

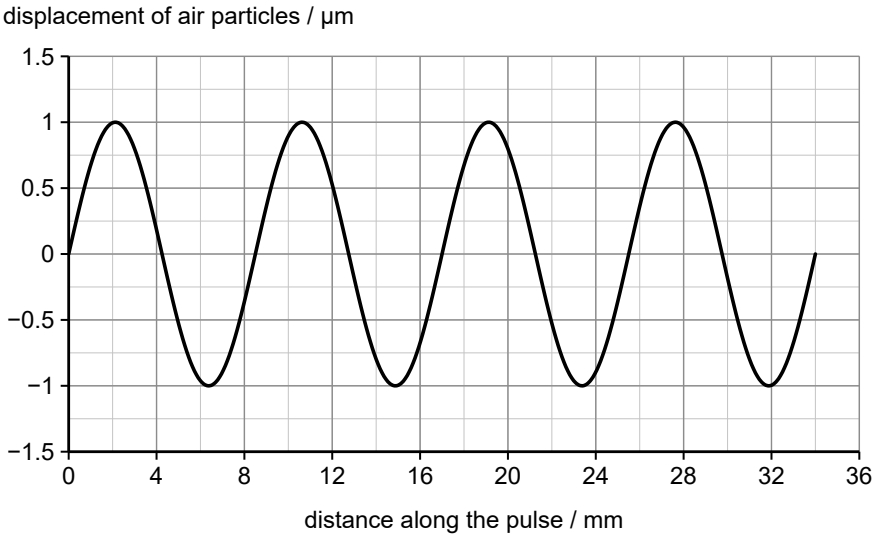



**Fig. 8.1**

speed = ..... m/s [2]

**(c)** A student says that the air near the sensor is carried to the obstacle by each pulse. State what a pulse transfers to the obstacle and explain why the student is wrong.

.....

..... [1]

[Total: 5]

**9** An airport uses electromagnetic waves for safety. X-rays are used to scan baggage, infrared cameras check passengers for fever and microwaves are used by radar.

**(a)** Five electromagnetic waves are listed: ultraviolet, microwaves, X-rays, infrared, visible light. Arrange them in order of increasing frequency, starting with the lowest.

lowest = .....

= .....

= .....

= .....

highest = ..... [2]

**(b)** Baggage-scanner operators are shielded from X-rays, but staff using an infrared fever-check camera need no shielding. Explain why X-rays are more hazardous than infrared radiation.

.....

.....

..... [1]

[Total: 3]

**10** This question is about light in a car.

**(a)** A driver looks in a plane rear-view mirror. Fig. 10.1 shows a ray of light from a car behind meeting the mirror at P. The ray makes an angle of 35° with the surface of the mirror. Calculate the angle between the incident ray and the reflected ray.

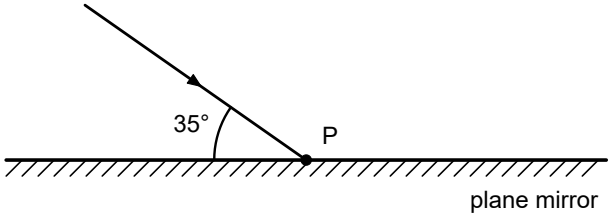



**Fig. 10.1**

angle = ..... ° [1]

**(b)** Fig. 10.2 shows a ray of light entering a thick glass block, part of a car headlamp lens, at point P. On Fig. 10.2 draw the normal at P and mark and label the angle of incidence *i* and the angle of refraction *r*.

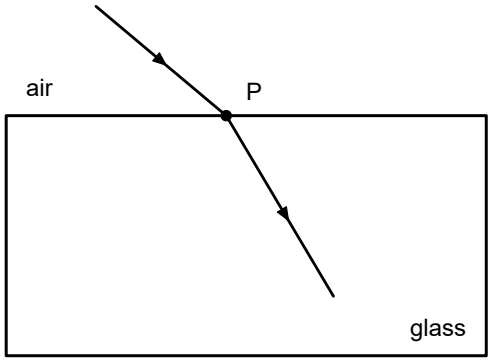



**Fig. 10.2**

[2]

**(c)** Answer the following about the glass.

**(i)** Define the refractive index of a medium.

.....

..... [1]

**(ii)** The glass has a refractive index of 1.5. The speed of light in a vacuum is $3.0 \times 10^8$ m/s. Calculate the time taken by light to cross a block of this glass of thickness 0.30 m.

time = ..... s [1]

[Total: 5]

**11** Fig. 11.1 shows the circuit for the heating element of a rear-window demister in a car.

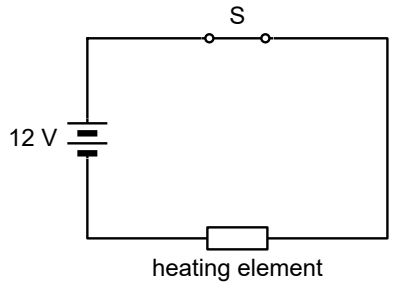



**Fig. 11.1**

**(a)** On Fig. 11.1 draw an arrow labelled **C** to show the direction of the conventional current and an arrow labelled **E** to show the direction of the electron flow, in the wire between the switch and the heating element.

[2]

**(b)** The heating element has resistance.

**(i)** State what is meant by the resistance of the heating element.

.....

..... [1]

**(ii)** With the engine off, the p.d. across the element is 12 V and the current in it is 5.0 A. With the engine running, the p.d. across the element rises to 14 V. Assuming that the resistance of the element does not change, calculate the new current in the element.

current = ..... A [1]

[Total: 4]

**12** Fig. 12.1 shows three brake lamps connected in parallel to a 12 V car battery. The ammeter $A$ reads 6.0 A, ammeter $A_1$ reads 2.5 A and ammeter $A_2$ reads 1.5 A.

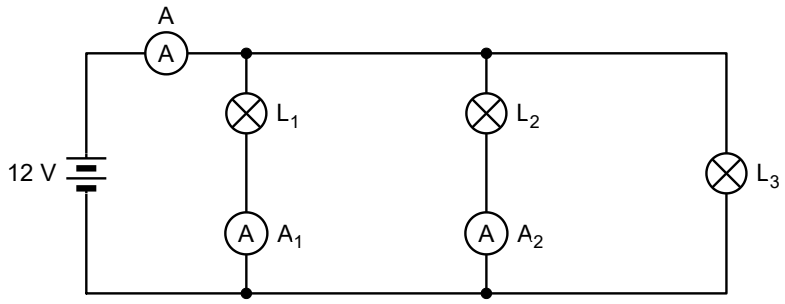



**Fig. 12.1**

**(a)** Calculate the current in lamp $L_3$.

current = ..... A [2]

**(b)** Lamp $L_2$ now blows and stops conducting. State the potential difference across lamp $L_3$ after this happens, and explain why the reading on $A_1$ does not change.

.....

.....

.....

..... [2]

[Total: 4]

**13** A magnetic sweeper is pulled along a road to collect steel nails that could puncture tyres.

**(a)** Fig. 13.1 shows the lower pole of the sweeper magnet touching steel nail A, and nail A touching steel nail B. Describe how nail A becomes a magnet, state the pole at the lower end of nail A, and explain why nail B is attracted to nail A.

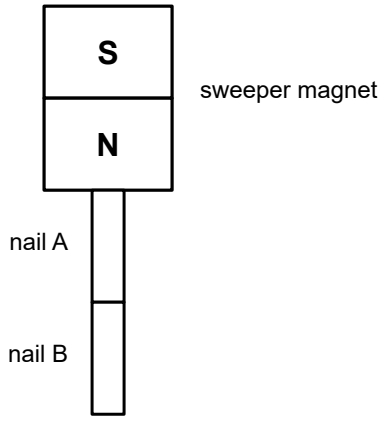



**Fig. 13.1**

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.....

..... [2]

**(b)** Fig. 13.2 shows the N pole of one bar magnet facing the N pole of another bar magnet. Draw the magnetic field pattern in the space between the poles, using at least three field lines from each pole, with arrows.




**Fig. 13.2**

[1]

[Total: 3]

**14** A smoke detector in an aircraft cabin contains a small amount of americium-241, which emits alpha particles.

**(a)** A student counts the emissions from a sample of americium-241 in five successive 10 s intervals and gets 31, 24, 29, 35 and 27 counts. Use these readings to explain what is meant by saying that nuclear decay is *random*, and state what is meant by saying that it is *spontaneous*.

.....

.....

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..... [2]

**(b)** State what an alpha particle consists of and explain why it is positively charged.

.....

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..... [1]

[Total: 3]

## Section B

Answer **one** question from this section.

**15** A mechanic services a school bus at a garage.

**(a)** The mechanic wires a three-pin plug for a mains-powered tyre pump. Table 15.1 shows the wire connected to each terminal in the plug. State what is wrong with this wiring and explain why it is dangerous.

**Table 15.1**

| terminal in the plug | colour of the insulation on the wire connected to it |
|---|---|
| L (the terminal that holds the fuse) | blue |
| N | brown |
| E | green and yellow |

.....

.....

.....

.....

..... [2]

**(b)** Mains appliances are made safe in different ways.

**(i)** The casing of the pump is made of metal and the earth wire is connected to it. A fault makes the live wire inside the pump come loose and touch the casing. Explain how the earth wire and the fuse protect the user.

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..... [2]

**(ii)** The mechanic's hand drill has a plastic casing and no earth wire. A colleague says that the drill is unsafe without an earth wire. State whether you agree, and give a reason for your answer.

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.....

..... [1]

**(c)** The mechanic then drives the bus along a straight road in the garage yard, where the speed limit is 20 km/h. Fig. 15.1 is the distance-time graph for the bus.

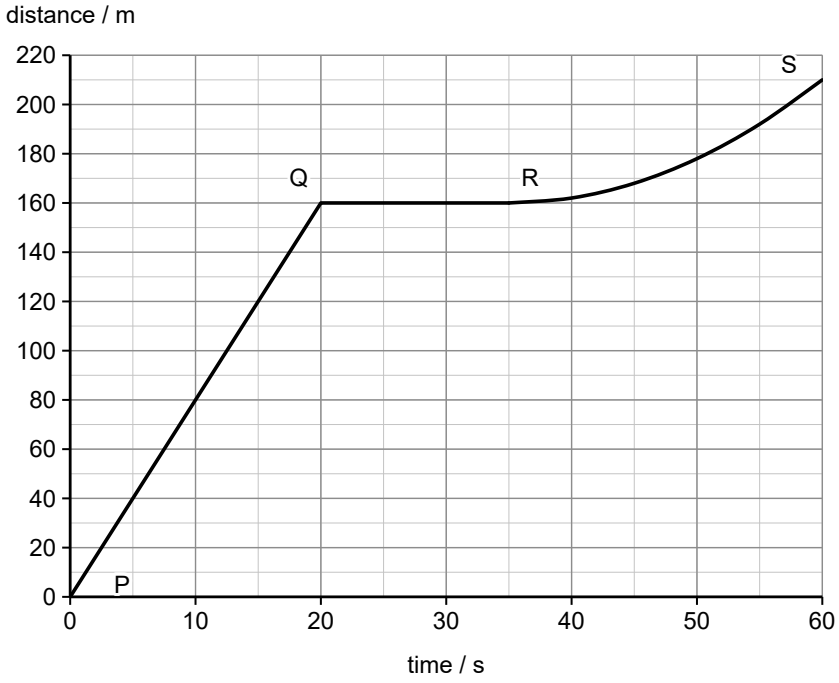



**Fig. 15.1**

**(i)** Explain how the shape of the graph shows that the bus is at rest in section QR and that its speed is increasing in section RS.

.....

.....

..... [1]

**(ii)** In one section the bus moves at constant speed. Identify this section and calculate the speed of the bus in it. Hence state, with a reason, whether the driver kept to the speed limit.

speed = ..... m/s [2]

**(d)** The mechanic works under the bus and drops a spanner from rest. Ignore air resistance.

**(i)** Calculate the speed of the spanner 0.60 s after it is released.

speed = ..... m/s [1]

**(ii)** Without further calculation, state the speed of the spanner 1.2 s after it is released and give a reason for your answer.

.....

.....

..... [1]

[Total: 10]

**16** This question is about energy transfer and magnets in road and rail vehicles.

**(a)** A hot engine block is cooled by water. Fig. 16.1 shows how the temperatures of the engine block and of the water change with time.

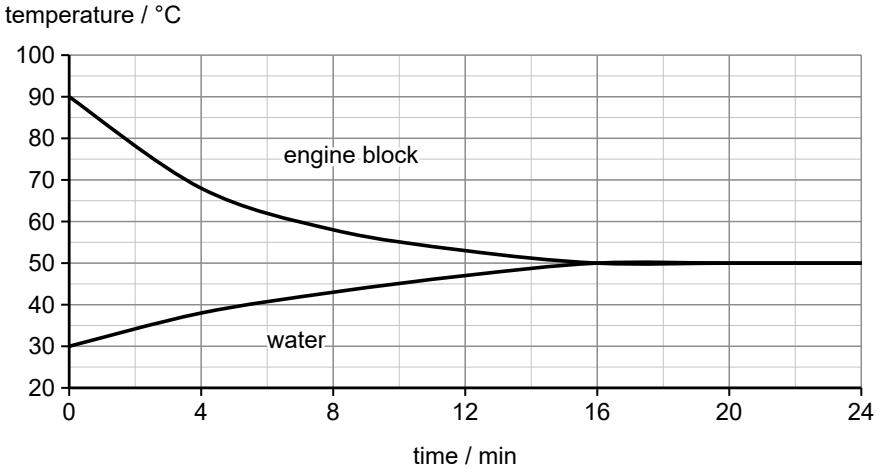



**Fig. 16.1**

**(i)** At a time of 4 min, calculate the difference between the temperature of the engine block and the temperature of the water, and state the direction in which energy is transferred between them.

.....

..... [1]

**(ii)** Use Fig. 16.1 to state the time at which the energy transfer between the engine block and the water stops, and give a reason for your answer.

.....

..... [1]

**(b)** Energy transfer matters in the carriages and at the depot of a railway.

**(i)** A carriage is heated by a copper pipe of hot water fixed near the floor along one wall. Explain how energy from the hot water in the pipe reaches a passenger sitting at the opposite side of the carriage. Name each process of energy transfer that you use.

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..... [2]

**(ii)** The oil cooler of a locomotive engine is built with many thin metal fins, which give it a much larger outer surface than a plain tube of the same size. Explain, in terms of radiation, why the fins help the hot oil to cool faster.

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..... [1]

**(c)** A mechanic tests three steel bars, **P**, **Q** and **R**, by bringing their ends close together. Table 16.1 shows what happens.

**Table 16.1**

| ends brought close together | what happens |
|---|---|
| left end of P and left end of Q | repel |
| left end of P and left end of R | attract |
| right end of P and left end of R | attract |

**(i)** Use Table 16.1 to deduce which bars are magnets and which bar is not a magnet. Explain your reasoning.

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..... [2]

**(ii)** Bar **Q** is dipped into iron filings. State where most of the filings stick, and what this shows about the strength of the magnetic force of a magnet.

.....

.....

..... [1]

**(d)** Describe an experiment to show that a force acts on a current-carrying wire in a magnetic field. In your experiment the wire moves upwards. State the direction in which the wire moves when the direction of the current and the poles of the magnet are both reversed at the same time, and explain your answer.

[2]

[Total: 10]