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Physics
Standard level
Paper 2

29 April 2026

Zone A morning | **Zone B** morning | **Zone C** morning

Session number

1 hour 30 minutes

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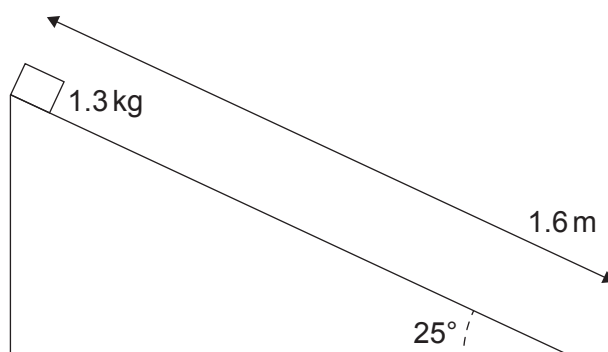
Instructions to students

- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Answer all questions.
- Answers must be written within the answer boxes provided.
- A calculator is required for this paper.
- A clean copy of the **physics data booklet** is required for this paper.
- The maximum mark for this examination paper is **[50 marks]**.



Answer **all** questions. Answers must be written within the answer boxes provided.

1. A box is at the top of a 1.6 m long ramp inclined 25° to the horizontal. The mass of the box is 1.3 kg.



- (a) Show that the gravitational potential energy of the box at the top of the ramp is about 9 J. [1]

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The box slides down the ramp from rest. At the end of the ramp, the speed of the box is 2.4 ms^{-1} .

- (b) (i) Calculate the kinetic energy of the box at the end of the ramp. [1]

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- (ii) Determine the coefficient of dynamic friction between the ramp and the box. [2]

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The box is then pushed up a different, frictionless ramp to a vertical height of h .

- (c) Explain why the work done is independent of the angle of the ramp. [1]

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2. An ideal gas is held in a container. Thermal energy is transferred to it by a heater. The heater works at a voltage of 220 V and the current in the heater is 2.0 A. The gas is heated for 30 s at a constant volume.

(a) Calculate the thermal energy transferred to the gas. [1]

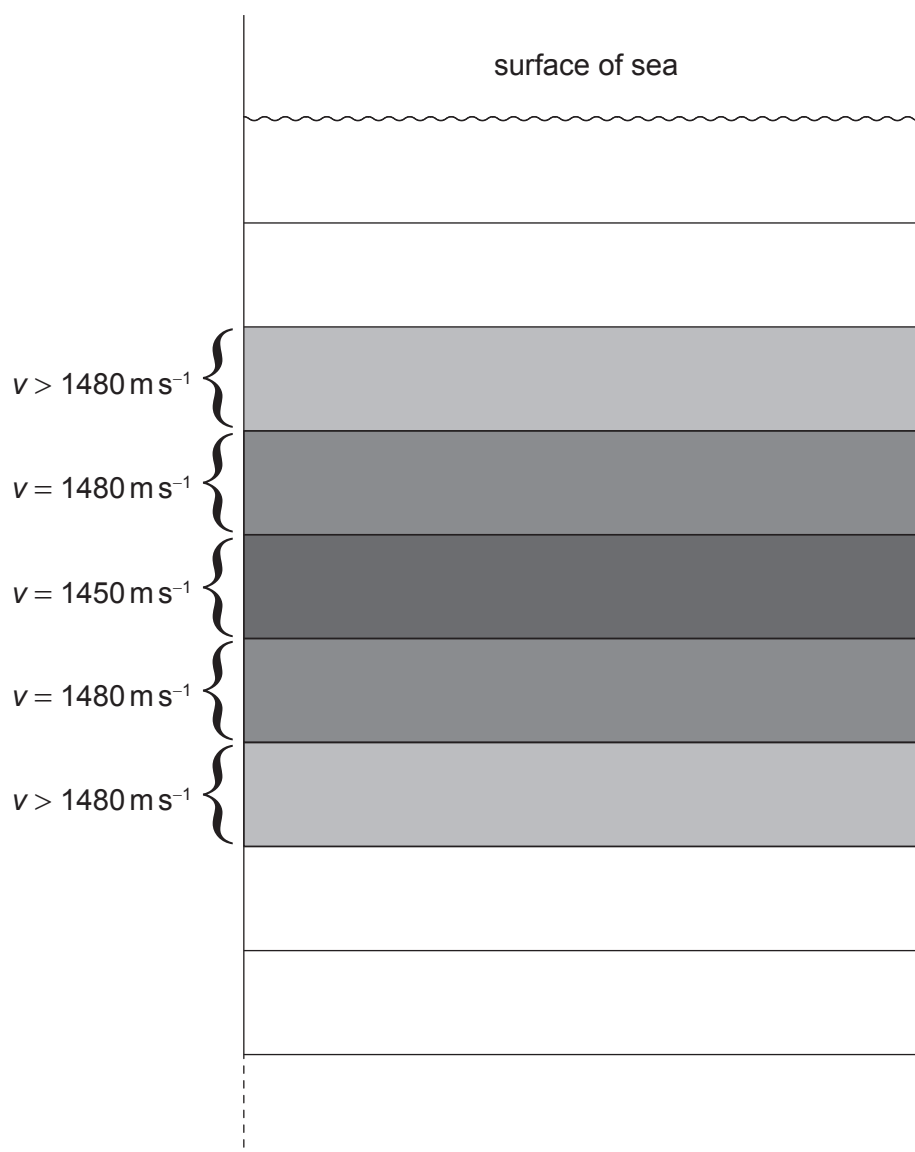
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(b) Explain, in terms of the motion of particles, how the increase in pressure arises. [2]

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3. As a result of the variation of temperature and pressure with depth, the speed of sound v in the sea varies so that it reaches a minimum value at a certain depth. This variation can be modelled by layers of constant decreasing speeds of sound up to that depth. Layers above or below that layer have increasing v , as shown in the diagram.

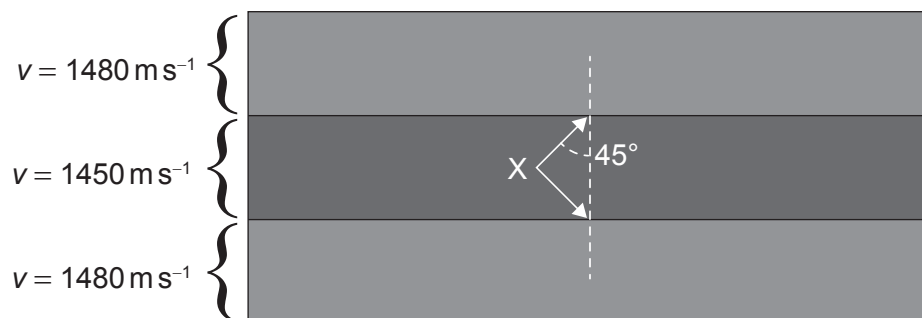


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(Question 3 continued)

A source at X, in the layer of minimum speed, emits a sound that is incident on a point in the boundary to an adjacent layer at 45.0° , as shown. The speed of sound in the layer of minimum speed is 1450 m s^{-1} and the speed of sound in the adjacent layer is 1480 m s^{-1} . The sound is refracted at the incident point.



(a) Calculate the angle of refraction.

[2]

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(b) Determine the critical angle for the sound emitted from X.

[1]

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(c) Describe the path of the sound emitted at X.

[3]

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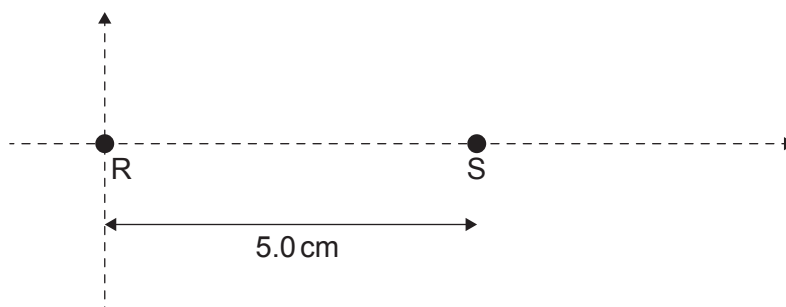
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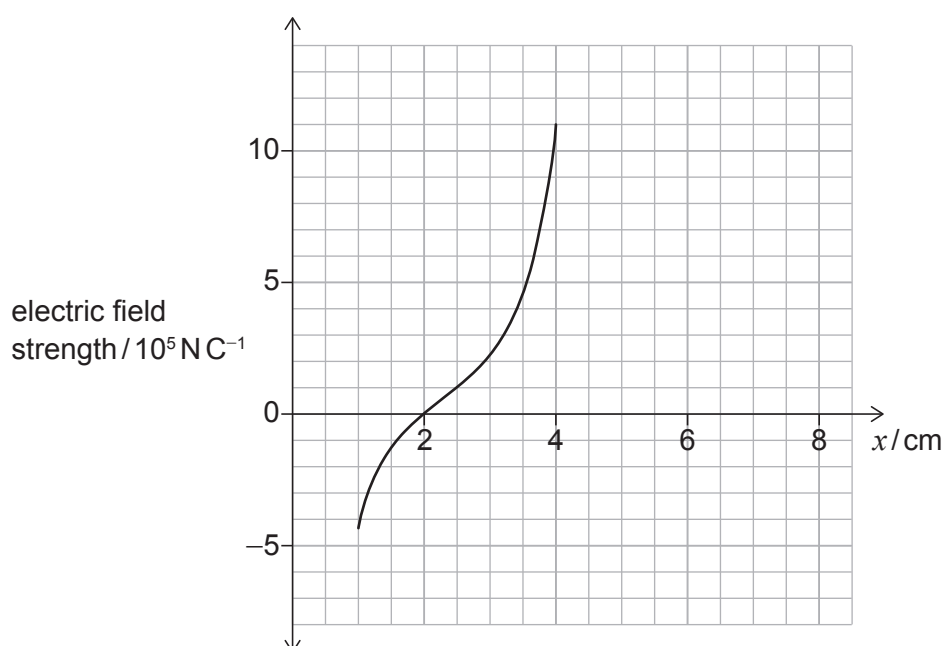
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4. Two electric point charges, R and S, are 5.0 cm apart.



The graph shows the variation of the resultant electric field strength due to these two charges along the line joining them, for the interval $1.0 \text{ cm} \leq x \leq 4.0 \text{ cm}$, where x is the horizontal position with origin at charge R.



- (a) State the definition of electric field strength at a point.

[2]

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(This question continues on the following page)



(Question 4 continued)

(b) Identify the sign of each charge.

[1]

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(c) Show that the ratio of the magnitudes of the charges is about 2.

[2]

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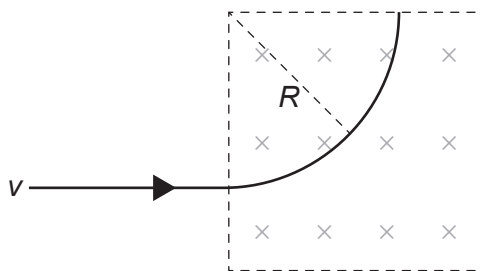


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5. A proton of velocity v , enters a region of magnetic field $B = 0.14 \text{ T}$ perpendicular to v and directed into the page so that the proton follows a curved path of radius R , as shown.



- (a) Determine in terms of v , the radius R .

[2]

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When a sample of ionized hydrogen gas is accelerated and enters a region of magnetic field, it shows multiple radii of curvature.

- (b) Explain how this accounts for the existence of isotopes.

[1]

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Isotopes produce slightly different wavelengths in their emission spectra.

The same electron transitions in hydrogen-1 and hydrogen-2 have wavelengths of 656.478 nm and 656.296 nm respectively.

- (c) Determine the difference in energy of these photons.

[2]

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6. The radioactive decay of rubidium $^{87}_{37}\text{Rb}$ into strontium $^{87}_{38}\text{Sr}$ is used to date rocks. The rocks do not contain strontium when they are formed.

(a) Identify the type of decay.

[1]

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- (b) A sample of a rock is analysed. It is found to contain 2.232 mg of rubidium-87 and 0.028 mg of strontium-87.

(i) Explain why the initial mass of rubidium-87 is 2.260 mg.

[1]

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(ii) Identify the value needed to determine the age of the rock.

[1]

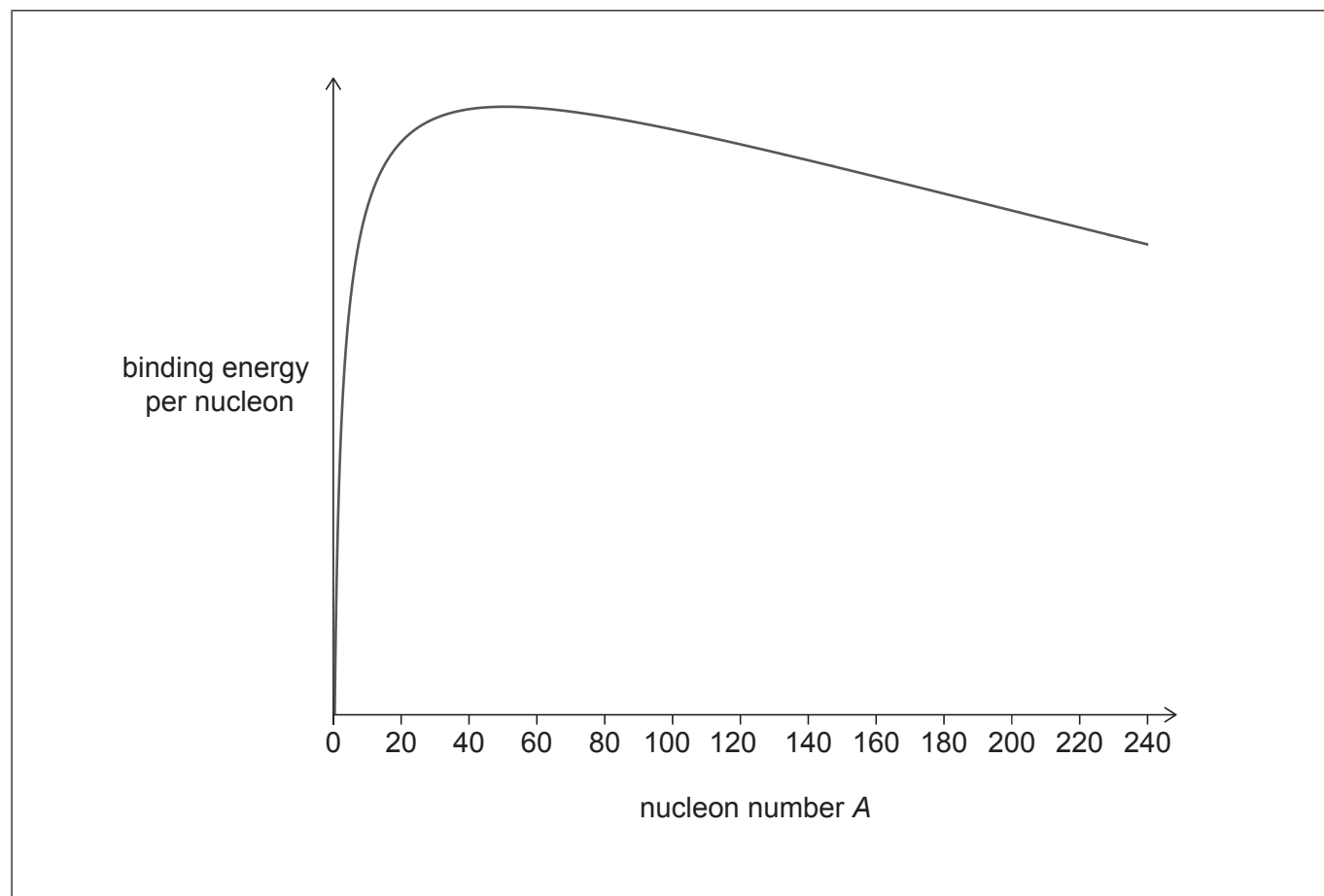
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(Question 6 continued)

- (c) The graph shows the variation of the binding energy per nucleon, with the nucleon number, for the elements in the periodic table.



- (i) Draw an X to represent the binding energy per nucleon of rubidium-87. [1]
- (ii) The nuclear mass of $^{87}_{37}\text{Rb}$ is 86.89 u .

Calculate, in MeV, the binding energy per nucleon of Rb-87. [2]

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7. Scientists are planning a skydive jump from a height of 39 km above the surface of the Earth. To reach that altitude, a skydiver is to be lifted in a capsule attached to a helium-filled balloon.



The fabric of the balloon has a surface area of $41\,000\text{ m}^2$ and a thickness of 0.021 mm . It is made of a plastic of density 1600 kg m^{-3} .

- (a) Show that the mass of the balloon is about 1400 kg .

[1]

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The balloon is held stationary and helium gas is pumped into it at a nearly atmospheric pressure of $P = 102\text{ kPa}$. The balloon is inflated up to a volume of 3700 m^3 . The ambient temperature is 15°C . The molar mass of helium is 4.0 g mol^{-1} .

- (b) Show that the mass of helium added is about 600 kg .

[2]

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(This question continues on the following page)



(Question 7 continued)

The balloon is released, lifting the capsule and skydiver into the air. The balloon accelerates upwards at 2.2 m s^{-2} . The density of air at 15°C is 1.2 kg m^{-3} .

- (c) Determine the combined mass of the capsule and the skydiver. The volume of the capsule is negligible compared to the volume of the balloon. [3]

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(Question 7 continued)

The balloon stops rising at a height of 39 km, where the external pressure and temperature are 0.35 kPa and -30°C respectively. A heater operates at 0.12 kW to maintain the interior of the capsule at a constant temperature of 15°C .



- (d) (i) Suggest why the conduction losses from the capsule to the surroundings can be considered negligible at 39 km.

[1]

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- (ii) The capsule has a surface area of 14 m^2 . Estimate the emissivity of the capsule. Do not consider any thermal radiation input to the capsule.

[2]

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(Question 7 continued)

The skydiver jumps from the capsule when it reaches a height of 39 km.

- (e) (i) The radius of the Earth is 6400 km. Show that g is about 9.7 ms^{-2} at a height of 39 km.

[2]

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- (ii) The air resistance can be considered negligible from a height of 35 km and over. Estimate the speed of the skydiver at 35 km.

[2]

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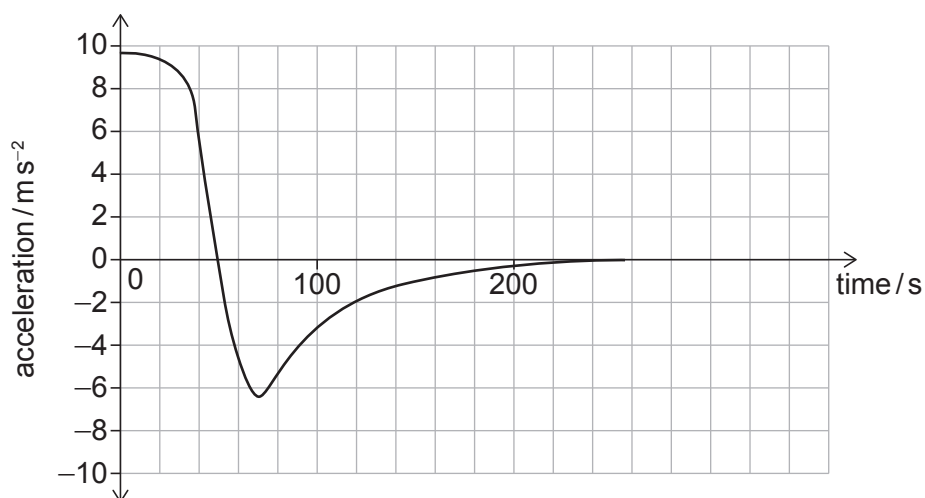
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(Question 7 continued)

The graph shows the variation with time of the acceleration of the skydiver, from the start of the dive to the opening of the parachute 260 s later, for a real jump performed in 2012.



The graph shows two areas, one above and one below the time axis.

- (f) (i) Identify what the areas represent. [2]

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- (ii) Explain how the areas compare. [1]

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(Question 7 continued)

- (g) The skydiver opens their parachute 260 seconds after jumping. Describe the subsequent motion of the skydiver.

[2]

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The real jump was tracked using thermal-imaging cameras which operate using infrared radiation.

- (h) Identify a possible frequency for this radiation.

[2]

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20EP20