IB Demystified

Examiners · Moderators · Mentors

Physics

Standard Level

Paper 2 — Mock Examination

Mock Exam 1

Calculator required

Time allowed: **1 hour 30 minutes**

Maximum mark: **50 marks**

Candidate information

Candidate name: . . . . . .

Session number: . . . . . .

Date: . . . . . .

Topic emphasis: mechanics, thermal physics, waves and oscillations, fields, nuclear and astrophysics

Instructions to candidates

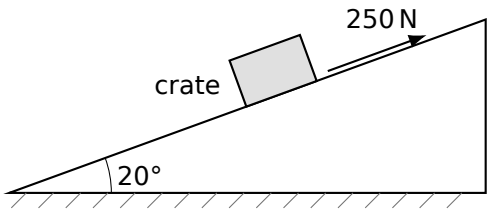
- Write your session number in the box on the cover.
- Do not open this examination paper until you are told to do so.
- Answer **all** questions.
- Answers must be written within the answer spaces provided.
- A calculator is required for this paper.
- A clean copy of the **physics data booklet** is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

Information for candidates

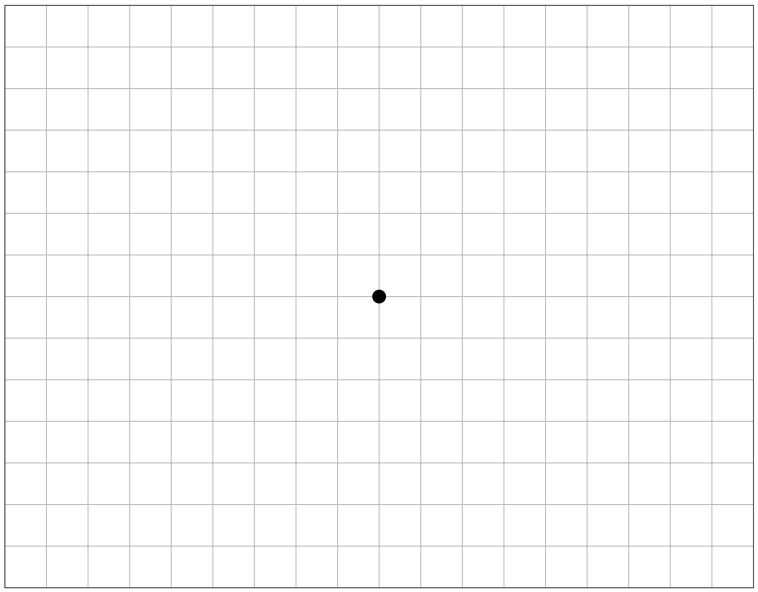
- Where necessary, take the magnitude of the gravitational field strength at the Earth's surface to be $g = 9.81\,\text{N}\,\text{kg}^{-1}$ and the speed of sound in air to be $340\,\text{m}\,\text{s}^{-1}$. Values of all other constants are given in the data booklet.
- Show all of your working. Marks may be awarded for a correct method even when the final numerical answer is incorrect.
- Final answers should be given to an appropriate number of significant figures, together with a correct unit.
- The number of marks available for each part of a question is shown in square brackets, for example **[2]**.

Answers written outside the answer spaces provided will not be marked.

1. A crate of mass 45 kg is pulled at **constant speed** up a rough incline by a rope that is parallel to the surface of the incline. The incline makes an angle of 20° with the horizontal and the tension in the rope is 250 N.



(a) Draw and label a free-body diagram showing the forces acting on the crate. **[2]**



(b) Show that the frictional force acting on the crate is about 100 N. **[2]**

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(c) Determine the coefficient of dynamic friction between the crate and the incline. **[2]**

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(d) The crate is pulled a distance of 8.0 m along the incline. Calculate the work done against friction. **[1]**

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(e) At the top of the incline the rope breaks and the crate slides back down. Assuming that the magnitude of the frictional force is unchanged, determine the acceleration of the crate. **[2]**

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(f) Determine the speed of the crate after it has slid 8.0 m back down the incline. **[2]**

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2. An insulated container holds 0.40 kg of water at a temperature of 30 °C. A block of ice of mass 0.25 kg at a temperature of −12 °C is placed in the water.

The following data are available:

specific heat capacity of ice	$= 2.1 \times 10^3\,\text{J kg}^{-1}\,\text{K}^{-1}$
specific heat capacity of water	$= 4.2 \times 10^3\,\text{J kg}^{-1}\,\text{K}^{-1}$
specific latent heat of fusion of ice	$= 3.3 \times 10^5\,\text{J kg}^{-1}$

(a) Explain, in terms of the behaviour of the molecules, why the temperature of the ice does not change while it is melting. **[2]**

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(b) Show that the energy required to raise the temperature of the ice to 0 °C is about 6×10^3 J. **[1]**

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(c) Deduce that not all of the ice melts. **[3]**

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(d) Determine the mass of ice that melts. **[2]**

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(e) State the final temperature of the contents of the container and outline the reasoning for your answer. **[2]**

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3. A block of mass 0.30 kg is attached to a horizontal spring and oscillates on a frictionless surface. The motion is simple harmonic with an amplitude of 6.0 cm and a period of 0.75 s.

(a) State what is meant by simple harmonic motion. **[2]**

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(b) Show that the angular frequency of the oscillation is about 8.4 rad s^{-1}. **[1]**

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(c) Calculate, for the block:

(i) the maximum speed; **[2]**

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(ii) the magnitude of the maximum acceleration. **[1]**

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(d) Determine the spring constant of the spring. **[2]**

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(e) The block is now displaced so that the amplitude of the oscillation is 12 cm. State and explain the effect, if any, of this change on the period of the oscillation. **[2]**

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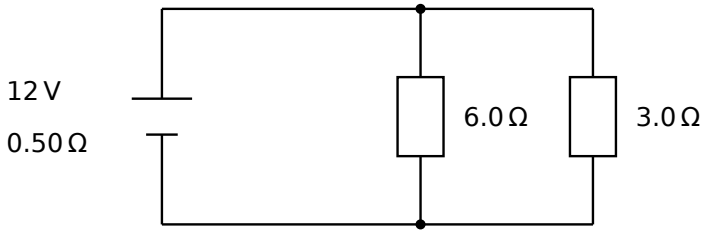
4. A cell of electromotive force (emf) 12 V and internal resistance 0.50 Ω is connected to two resistors of resistance 6.0 Ω and 3.0 Ω as shown.



(a) Define the *electromotive force* of a cell. **[1]**

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(b) Show that the current in the cell is 4.8 A. **[2]**

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(c) Calculate the potential difference across the 3.0 Ω resistor. **[1]**

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(d) Determine the power dissipated in the 3.0 Ω resistor. **[2]**

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(e) Determine the percentage of the total power delivered by the cell that is dissipated inside the cell. **[2]**

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(f) A third resistor is now connected in parallel with the other two. State and explain the effect of this change on the terminal potential difference of the cell. **[2]**

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5. Sodium-24 ($^{24}_{11}$Na) is an artificial radioactive nuclide that decays by beta-minus emission. The half-life of sodium-24 is 15 hours. A freshly prepared sample of sodium-24 has an activity of 4.0×10^5 Bq.

(a) Write down the nuclear equation for the decay of a sodium-24 nucleus. **[2]**

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(b) State what is meant by the *half-life* of a radioactive nuclide. **[1]**

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(c) Show that the decay constant of sodium-24 is about $1.3 \times 10^{-5}\,\text{s}^{-1}$. **[1]**

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(d) Determine the number of sodium-24 nuclei in the freshly prepared sample. **[2]**

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(e) Calculate the activity of the sample 40 hours after it was prepared. **[2]**

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(f) The kinetic energy of the emitted beta particles varies continuously from zero up to a maximum value. Outline what this observation suggests about the decay. **[1]**

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End of examination.

Total: 50 marks