ESSENTIAL

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# PHYSICS

Practice Questions & Exam Papers

# QUESTIONS & PAPERS

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# KEY AREA INDEX GRIDS

## Practice Exam A

| | Key area | Paper 1 | Paper 2 | | | | Check |
|---|---|---|---|---|---|---|---|
| | | Multiple choice | Calculate/ show that | Determine/ sketch/ draw | State/ explain/ describe | Use your knowledge | |
| Our dynamic Universe | ODU1 Motion – equations and graphs | 1, 2, 3 | 1ai, 1b, 1c, 2a | 1aii | | | 15 |
| | ODU2 Forces, energy and power | 4, 5 | 2b, 2c | | | | 8 |
| | ODU3 Collisions, explosions and impulse | 6 | 3a, 3c | | 3b | | 10 |
| | ODU4 Gravitation | 7 | 4a, 4b | | 4c | | 10 |
| | ODU5 Special relativity | | 5 | | | | 3 |
| | ODU6 The expanding Universe | 8, 9 | 6a, 6c | | 6b | | 9 |
| Particles and waves | PW1 Forces on charged particles | 14, 15, 16, 17 | 8bi, 8bii, 8biii | 8a | | 9, 16 | 20 |
| | PW2 The Standard Model | 10, 11, 12, 13 | | | 7a, 7b | | 7 |
| | PW3 Nuclear reactions | 18 | 10c, 10d | | 10a, 10b | | 12 |
| | PW4 Inverse square law | 21 | | | | | 1 |
| | PW5 Wave–particle duality | | 11c | 11d | 11a, 11b | | 9 |
| | PW6 Interference | 19 | 12b | | 12a, 12c | | 11 |
| | PW7 Spectra | | 14b | | 14a | | 5 |
| | PW8 Refraction of light | 20 | 13bii | 13a | 13bi | | 10 |

| | Key area | Paper 1 | Paper 2 | | | | Check |
|---|---|---|---|---|---|---|---|
| | | Multiple choice | Calculate/ show that | Determine/ sketch/ draw | State/ explain/ describe | Use your knowledge | |
| Electricity | E1 Monitoring and measuring AC | 22 | 15a, 15b | | | | 9 |
| | E2 Current, potential difference, power and resistance | | | | | | 0 |
| | E3 Electrical sources and internal resistance | | | 17b, 17c | 17a | | 7 |
| | E4 Capacitors | 23 | 18a, 18b | | | | 7 |
| | E5 Semiconductors and p–n junctions | 24, 25 | | | | | 2 |
| | | | | | | Total | 155 |

# Practice Exam B

| | Key area | Paper 1 | Paper 2 | | | | Check |
|---|---|---|---|---|---|---|---|
| | | Multiple choice | Calculate/ show that | Determine/ sketch/ draw | State/ explain/ describe | Use your knowledge | |
| Our dynamic Universe | ODU1 Motion – equations and graphs | 1, 4, 5 | 1a, 1bi, 1bii, 1biii | 1biv, 1bv | | | 19 |
| | ODU2 Forces, energy and power | 2, 6, 7 | 2a, 2b, 2c, 3a, 3b, 13 | | 3c | | 20 |
| | ODU3 Collisions, explosions and impulse | 3 | 4a, 4b, 4c, 4d | | 4e | | 13 |
| | ODU4 Gravitation | 8, 9 | | | | | 2 |
| | ODU5 Special relativity | 10 | 5a, 5b | | | | 6 |
| | ODU6 The expanding Universe | 11, 14 | 6a, 6b, 6c, 7a | | 7b, 7c | | 19 |
| Particles and waves | PW1 Forces on charged particles | 12, 13 | | | | 8, 14 | 8 |
| | PW2 The Standard Model | 15, 16 | | | 9a, 9b, 9c | | 8 |
| | PW3 Nuclear reactions | 25 | | 10a | 10b | | 9 |
| | PW4 Inverse square law | 17 | 11b | 11a | 11c | | 7 |
| | PW5 Wave–particle duality | | 12a, 12b | | 12c | | 9 |
| | PW6 Interference | 18 | | | | | 1 |
| | PW7 Spectra | | | | | | 0 |
| | PW8 Refraction of light | 19 | 15a, 15b | | | | 7 |

| | Key area | Paper 1 | Paper 2 | | | | Check |
|---|---|---|---|---|---|---|---|
| | | Multiple choice | Calculate/ show that | Determine/ sketch/ draw | State/ explain/ describe | Use your knowledge | |
| Electricity | E1 Monitoring and measuring AC | | | | | | 0 |
| | E2 Current, potential difference, power and resistance | 21, 22 | | | | | 3 |
| | E3 Electrical sources and internal resistance | | 16ai, 16aii, 17a | | 16b | | 10 |
| | E4 Capacitors | 20, 23 | 17b, 17di, 17dii | 17c | | | 13 |
| | E5 Semiconductors and p–n junctions | 24 | | | | | 1 |
| | | | | | | Total | 155 |

# Question type: Multiple-choice

## HOW TO ANSWER

Do not expect all the multiple-choice questions to be easy. Some are straightforward and some are difficult. Although all multiple-choice questions are worth 1 mark, some require more work than a 1-mark question in an extended questions paper, so do not be concerned if you are performing two or three calculations in order to reach an answer.

In Higher Physics there is one correct answer to each multiple-choice question. There are also four wrong answers designed to distract you (distractors). If you can, work out an answer before looking at the possible answers given in the question.

**Top Tip!**

A good way to avoid being distracted is to cover the possible answers while you read and think about the question.

If you are not confident about an answer, you can improve your chances by eliminating the answers that you know are definitely wrong. Answers can be eliminated for a number of reasons, such as incorrect unit, a velocity greater than the speed of light or a value for an answer that is out by a large factor (for example, mass of astronaut 300 kg). Occasionally distractors are obvious.

In the exam, if you cannot achieve an answer that is one of the responses, put a line through one of the boxes in the answer grid; any answer has a 1 in 5 chance of being correct.

Where a question is complicated, write down notes and working on the blank pages at the end of the question paper or beside the actual question. Do not use the answer grid for working. Remember to cross out any rough working for these multiple-choice questions when you have finished.

**Top Tip!**

Do not spend too much time on one question. Allocate a maximum of two minutes for any individual question. Do not be concerned if some questions are answered immediately and others require a lot of consideration. This is normal in these types of questions.

# Our dynamic Universe

STUDENT MARGIN

1 Which of the following could you determine from a speed–time graph?

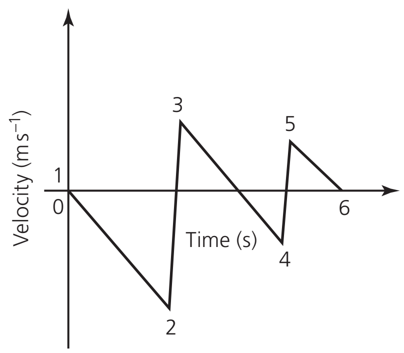
A power
B force
C distance
D displacement
E momentum

Our dynamic Universe 1

2 The graph shows the velocity–time relationship for a ball dropped from a height at time $t = 0$.

Between which points is the ball in contact with the ground?

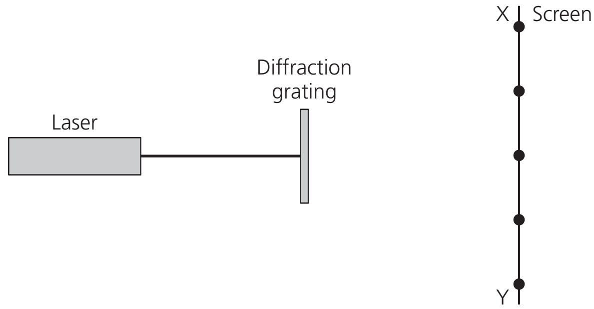
A 1 and 2
B 3 and 4
C 5 and 6
D 2 and 3, and 4 and 5
E 3 and 4, and 5 and 6




Our dynamic Universe 1

MARKS | STUDENT MARGIN

**19** A laser is projected onto a diffraction grating, as shown.
The light has a wavelength of 565 nm.
The spacing of the grating $d = 3{\cdot}5 \times 10^{-6}$ m.
Bright spots are seen on the screen, as shown.

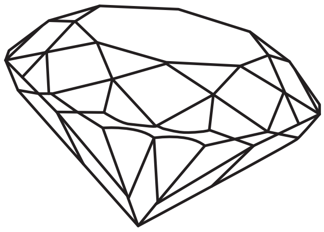



**a)** Calculate the angle between the central and the second order maximum. **4** Particles and waves 6
*Space for working and answer*

**b)** A light detector is moved between points X and Y. **2** Particles and waves 6
Describe what it would register.

**(6)**

**20** Diamond has a relatively high refractive index of 2·42, which affects its critical angle and causes its 'sparkle' when illuminated with light.



**a)** State what is meant by critical angle. **1** Particles and waves 8

**b)** Calculate the critical angle for diamond. **3** Particles and waves 8
*Space for working and answer*

**(4)**

**Duration**: 3 hours
**Total marks**: 155

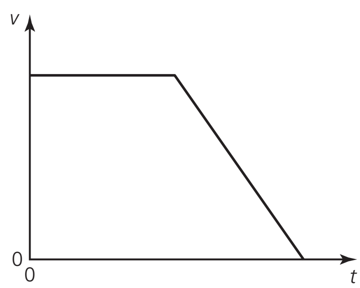
**PAPER 1 – 25 marks**
Attempt ALL questions.

**PAPER 2 – 130 marks**
Attempt ALL questions.
Reference may be made to the Relationships sheet on page xi and to the Data sheet on page xiii.
Care should be taken to give an appropriate number of significant figures in the final answers to calculations.
Write your answers clearly in the spaces provided in this paper. Any rough work must be written in this paper. You should score through your rough work when you have written your final copy.
Use **blue** or **black** ink.

# Paper 1

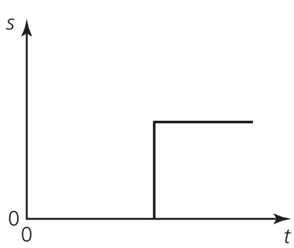
**Total marks**: 25
**Duration**: 45 minutes
Attempt ALL questions.

| | MARKS | STUDENT MARGIN |
|---|---|---|
| **1** The following velocity–time graph represents the motion of a car travelling in a straight line. | **1** | Our dynamic Universe 1 |

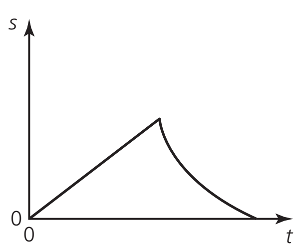



Which of the following displacement–time graphs represents the same motion?

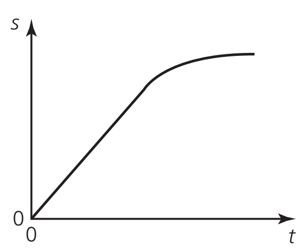
**A**



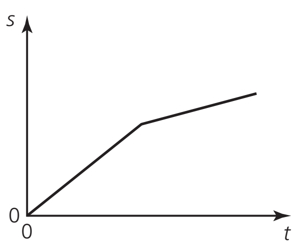

**B**



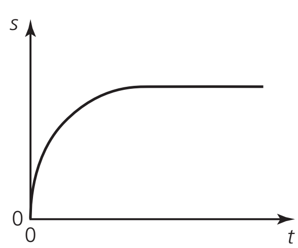

**C**




**D**




**E**



# Paper 2

**Total marks**: 130

**Duration**: 2 hours and 15 minutes

Attempt ALL questions.

Reference may be made to the Data sheet on page xi and to the Relationships sheet on page xiii.

Care should be taken to give an appropriate number of significant figures in the final answers to calculations.

Write your answers clearly in the spaces provided in this paper. Any rough work must be written in this paper. You should score through your rough work when you have written your final copy.

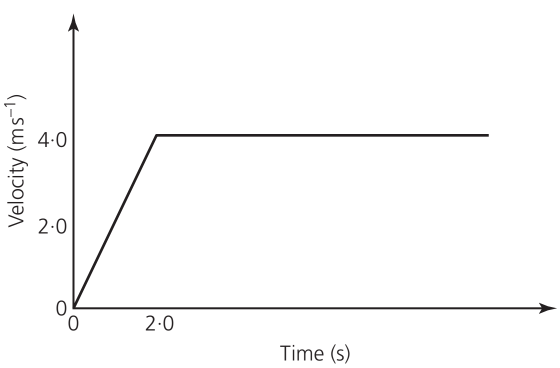
Use **blue** or **black** ink.

MARKS STUDENT MARGIN

**1** Hillend is Europe's longest dry ski run with an overall piste length of 400 m, total vertical drop of 110 m and average slope angle of 16°.

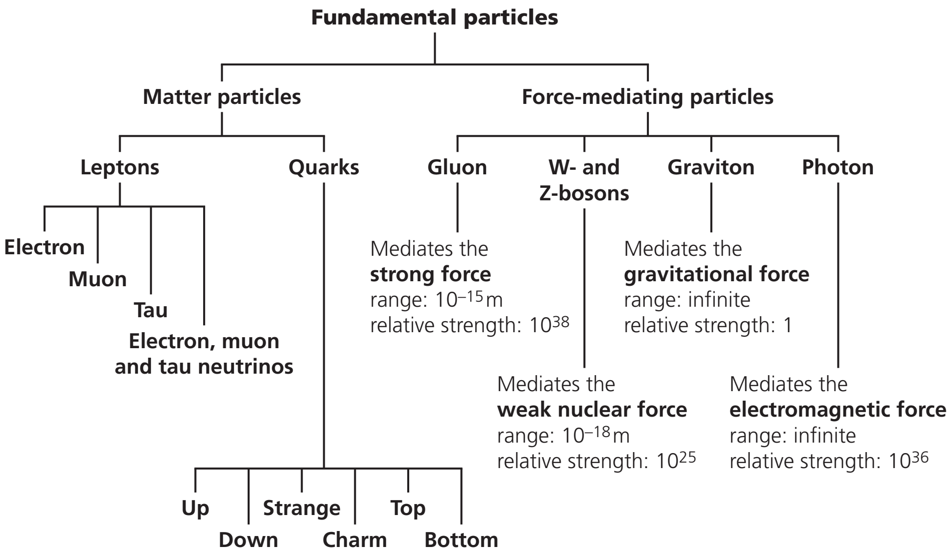
A skier of total mass 70 kg ascends the slope using the ski-tow and then completes a run down the slope.

**a)** The velocity–time graph of the first part of the uphill ski-tow journey is shown.



MARKS | STUDENT MARGIN

**9** The diagram shows the family of fundamental particles.




**a)** The gluon is the force-mediating particle for the strong force. The relative strength of the strong force is $10^{38}$. It is 13 orders of magnitude stronger than the weak nuclear force. — **1** — Particles and waves 2

What is the relative strength of the weak nuclear force?

**b)** Which force-mediating particle(s) is/are associated with the weak nuclear force? — **1** — Particles and waves 2

**c)** State which quarks combine to form the following. Justify your answers. — **4** — Particles and waves 2

**(i)** a proton

**(ii)** a neutron

**(6)**

**10 a)** Using the following data, determine a value for the binding energy **per nucleon** for the uranium nucleus $^{235}_{92}U$. — **6** — Particles and waves 3

Mass of $^{235}_{92}U$ nucleus : $390{\cdot}206 \times 10^{-27}$ kg

Mass of proton: $1{\cdot}672\,62 \times 10^{-27}$ kg

Mass of neutron: $1{\cdot}674\,29 \times 10^{-27}$ kg

*Space for working and answer*

# Practice Exam A

## Paper 1

| Question | Answer | Commentary with hints and tips |
|---|---|---|
| **1** | C | The area under a velocity–time graph is the displacement for that part of the journey. Initially constant velocity means displacement increases at a constant rate. The constant rate of decrease in velocity means the rate of increase in displacement is positive but decreasing. |
| **2** | E | The definition of acceleration is the rate of change of velocity. For a constant 5·0 m s$^{-2}$ acceleration, velocity increases at a rate of 5·0 m s$^{-1}$ every second. |
| **3** | E | The gradient of a velocity–time graph is the acceleration of the object. Each $v$–$t$ has a constant gradient, so the value of acceleration must be a constant (horizontal line). The $v$–$t$ gradient is negative. |
| **4** | D | Newton's first law means that constant or zero velocity implies balanced forces in the velocity vector direction. Constant horizontal and vertical velocity requires balanced forces in both the horizontal and vertical. |
| **5** | C | Resolving the vertical weight force vector ($W = mg$) into components parallel and perpendicular to the slope gives answer C. |
| **6** | C | Conservation of total linear momentum ($p = mv$) requires that the total momentum before and after the collision is the same. The velocity has halved so the total mass has doubled. |
| **7** | C | Using $F = G\frac{m_1 m_2}{r^2}$ <br> where $m_1 = 4{\cdot}2 \times 10^{24}$, $m_2 = 1{\cdot}8 \times 10^4$ and $r = 3{\cdot}0 \times 10^7$ gives answer C. Forgetting to square $r$ is a very common error. |
| **8** | C | Evidence supporting the existence of dark energy comes from the accelerating rate of expansion of the Universe. |
| **9** | D | Reading the graph shows that: <br> ▸ the area under the curve (which is proportional to the total energy emitted) increases with temperature increase <br> ▸ the peak wavelength value increases (moves right) as temperature decreases <br> ▸ larger values of emitted energy occur for smaller values of wavelength $\lambda$. <br> Therefore, I and II are correct. |
| **10** | E | Electron ≤ 10$^{-18}$ m; proton ≤ 10$^{-15}$ m; helium nucleus (two protons + two neutrons) > proton size. |
| **11** | D | From the course specification: fermions, the matter particles, consist of quarks (six types: up, down, strange, charm, top, bottom) and leptons (electron, muon and tau, together with their neutrinos). |
| **12** | E | The force-mediating particles are bosons: photons (electromagnetic force), W- and Z-bosons (weak force), and gluons (strong force). |
| **13** | B | The emitted electron has a range of kinetic energy but the nuclear decay is a quantum change and so should always have the same energy. This must mean another particle is emitted (the neutrino). |
| **14** | B | Field lines show the direction of force experienced by a unit positive test charge. Like charges repel. |
| **15** | A | The definition of the volt comes directly from $E_W = QV$, so $V = \frac{E_W}{Q}$. |
| **16** | C | The left-hand rule for positive charges in magnetic fields predicts the proton will be deflected upwards. The velocity vector direction changes but the velocity vector magnitude stays the same. |

| Question | Answer | Commentary with hints and tips |
|---|---|---|
| **17** | D | Hint: You need to know the basic operation of particle accelerators in terms of acceleration by electric field and deflection by magnetic fields. |
| **18** | B | Description of beta decay as the first evidence for the neutrino. |
| **19** | E | Coherent sources have a constant phase difference, i.e. the same frequency and wave speed in the medium. |
| **20** | D | Refractive index is always >1. Angles are measured between the ray and the normal. |
| **21** | D | Irradiance to distance is an inverse square relationship. Therefore, increasing the distance by a factor of 3 reduces the irradiance by a factor of 9 ($3^2$). |
| **22** | C | $V_{pk} = \sqrt{2}V_{rms}$ therefore $V_{rms} = \frac{V_{pk}}{\sqrt{2}}$ |
| **23** | B | $E = \frac{1}{2}CV^2$; a common error is to forget to square the voltage. |
| **24** | C | Insulators do not conduct because there are no charge carriers in the conduction band and the energy gap between the valence and conduction bands is too large for the charge carriers to move into the conduction bands. |
| **25** | D | In the depletion region of the p–n junction, the concentration of free charge carriers is reduced by the combination of electrons and holes on the formation of the junction. |

# Paper 2

| Question | | | Expected response | Max. mark | Commentary with hints and tips |
|---|---|---|---|---|---|
| **1** | **a)** | **(i)** | From the graph,<br>$a = \frac{4\cdot0}{2\cdot0} = 2\cdot0\ \text{m s}^{-2}$ (1)<br>$F = ma$ (1)<br>$F = 70 \times 2 = 140\,\text{N}$ (1) | **3** | The slope of a *v–t* graph is the acceleration of the object.<br>The resultant (unbalanced) force gives rise to the acceleration of the object. |
| | | **(ii)** | From the graph, $a = 0\,\text{m s}^{-2}$,<br>therefore $F = 0\,\text{N}$ | **1** | The slope of a *v–t* graph is the acceleration of the object. A horizontal line has zero gradient. |
| | **b)** | | $E_k = E_p$<br>$E_k = mgh$ (1)<br>$E_k = 70 \times 9{\cdot}8 \times 110$ (1)<br>$E_k = 7{\cdot}546 \times 10^4\,\text{J}$<br>$E_k = 7{\cdot}5 \times 10^4\,\text{J}$ (1) | **3** | Conservation of energy means that the maximum kinetic energy at the bottom of the slope is the total potential energy at the top of the slope.<br>Poorest significant figure in the question is 2 s.f., so answer to 2 s.f. |
| | **c)** | | $E_k = \frac{1}{2}mv^2$ (1)<br>$E_k = \frac{1}{2} \times 70 \times 20^2$<br>$E_k = 1{\cdot}4 \times 10^4\,\text{J}$ (1)<br>$E_w = Fs$<br>$(7{\cdot}5 \times 10^4 - 1{\cdot}4 \times 10^4) = F \times 400$<br>$F = 1{\cdot}5 \times 10^2\,\text{N}$ (1) | **3** | Some of the original potential energy is dissipated by work against friction. The difference between the maximum and actual kinetic energy gives the value of work against friction.<br>Poorest significant figure in the question is 2 s.f., so answer to 2 s.f. |
| | | | | **(10)** | |