Physics Unit 3 & 4 — Practice Exam 1 — Answers & Explanations

Answers to the 18 questions in the free preview.

Section A — multiple choice

1. B. the gravitational force of the book on Earth

Newton's third-law pairs act on two different objects and are the same type of force: "Earth pulls the book" pairs with "the book pulls Earth". The normal force of the table on the book balances the book's weight, but that is Newton's first law (both forces act on the book), not a third-law pair — the most common error on this idea.

2. C. 2.04 s

The vertical component is $20.0\sin(30.0^\circ) = 10.0$ m s⁻¹. The time to the top is $\frac{10.0}{9.81} = 1.02$ s and the flight is symmetrical, so the total time is 2.04 s. 1.02 s stops at the highest point; 3.53 s (and half of it, 1.77 s) uses the horizontal component $20.0\cos(30.0^\circ)$.

3. B. 12.9 m s⁻¹

With no friction, the horizontal component of the normal force provides the centripetal force: $\tan(\theta) = \frac{v^2}{rg}$, so $v = \sqrt{rg\tan(12.0^\circ)} = \sqrt{80.0 \times 9.81 \times 0.2126} = 12.9$ m s⁻¹. 28.0 m s⁻¹ leaves out $\tan(\theta)$, 60.8 m s⁻¹ divides by it, and 4.12 m s⁻¹ leaves out g.

4. B. 3.0 J

Momentum is conserved: $2.0 \times 3.0 = 3.0v$, so $v = 2.0$ m s⁻¹. Kinetic energy before is $\frac{1}{2}(2.0)(3.0)^2 = 9.0$ J and after is $\frac{1}{2}(3.0)(2.0)^2 = 6.0$ J, so 3.0 J is transformed (to heat and sound). The collision is inelastic, so 0 J is wrong.

5. B. 6.32 m s⁻¹

The elastic potential energy becomes kinetic energy: $\frac{1}{2}kx^2 = \frac{1}{2}mv^2$, so $v = x\sqrt{\frac{k}{m}} = 0.10\sqrt{4000} = 6.32$ m s⁻¹. 4.47 m s⁻¹ and 8.94 m s⁻¹ drop the $\frac{1}{2}$ from only one side; 20.0 m s⁻¹ uses x instead of x^2.

6. A. 2.45 N kg⁻¹

The altitude equals Earth's radius, so the satellite is $2R_E$ from Earth's centre. $g = \frac{GM_E}{(2R_E)^2}$, a quarter of the surface value: $\frac{9.81}{4} = 2.45$ N kg⁻¹. 4.91 N kg⁻¹ uses the inverse (not inverse-square) law.

7. D. 2.0 m

At P the fields are equal in magnitude: $\frac{kQ}{x^2} = \frac{k(4Q)}{(3.0-x)^2}$, where x is the distance from $+Q$. Then $3.0 - x = 2x$, so $x = 1.0$ m, and P is 2.0 m from the $+4Q$ charge. The null point is closer to the smaller charge. 1.0 m is the distance from $+Q$.

8. D. towards the bottom of the page

For a positive charge moving right in a field into the page, the right-hand rule gives a force towards the top of the page. The electron is negative, so the force is reversed: towards the bottom of the page. The force is always perpendicular to both v and B, so it cannot be into or out of the page.

9. A. Electric field lines begin on positive charges and end on negative charges.

Gravitational forces are only attractive; magnetic poles always come in pairs (no monopoles have been observed); and a magnetic field exerts no force on a stationary charge ($F = qvB$ with $v = 0$).

10. C. 17.0 V

$V_2 = 240 \times \frac{60}{1200} = 12.0$ V RMS, and $V_{\text{peak}} = \sqrt{2} \times 12.0 = 17.0$ V. 12.0 V is the RMS value; 339 V is the primary peak.

11. D. Peak EMF: doubled; Frequency of the output: doubled

Doubling the rotation rate halves the time for each change of flux, so the peak EMF ($\varepsilon = -N\frac{\Delta\Phi_B}{\Delta t}$) doubles, and the number of cycles each second — the frequency — also doubles.

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12. B. 400 W

$I = \frac{P}{V} = \frac{50\,000}{5000} = 10$ A and $P_{\text{loss}} = I^2R = 100 \times 4.0 = 400$ W. 6.25 MW uses $\frac{V^2}{R}$ with the transmission voltage, which is not the voltage across the lines; 40 W is the voltage drop IR mistaken for a power.

13. A. reverses the direction of the current in the coil every half-turn, so the coil keeps turning in the same direction

Without the commutator, the forces on the coil would reverse the rotation each half-turn and the coil would oscillate to rest. Reversing the current every half-turn keeps the torque in the same rotational direction.

14. C. 3.0 mm

$\Delta x = \frac{\lambda L}{d} = \frac{600\times10^{-9}\times2.0}{0.40\times10^{-3}} = 3.0 \times 10^{-3}$ m. Converting the slit separation from millimetres is the usual source of error.

15. A. Maximum kinetic energy of photoelectrons: unchanged; Photocurrent: increases

Each photon still has energy hf, so the maximum kinetic energy $hf - \phi$ is unchanged. A more intense beam delivers more photons each second, so more photoelectrons are emitted and the photocurrent increases. The wave model wrongly predicts that the kinetic energy would increase with intensity.

16. C. 1.00 × 10⁻¹⁰ m

$E_k = qV$, so $p = \sqrt{2m_eE_k} = \sqrt{2 \times 9.11 \times 10^{-31} \times 1.60 \times 10^{-19} \times 150}$ and $\lambda = \frac{h}{p} = 1.00 \times 10^{-10}$ m. 4.01 × 10⁻²⁰ m uses 150 J instead of 150 eV; 8.28 × 10⁻⁹ m treats the electron as a photon ($\lambda = \frac{hc}{E}$).

17. C. 103 nm

$\Delta E = 13.6\left(1 - \frac{1}{9}\right) = 12.09$ eV and $\lambda = \frac{hc}{\Delta E} = \frac{4.14\times10^{-15}\times3.00\times10^{8}}{12.09} = 1.03 \times 10^{-7}$ m. 122 nm is the $n = 2 \to 1$ line, 97.4 nm the $n = 4 \to 1$ line and 91.3 nm the ionisation energy (13.6 eV).

18. D. 11 μs

$\gamma = \frac{1}{\sqrt{1-0.98^2}} = 5.03$, and the dilated time is $t = t_0\gamma = 2.2 \times 5.03 = 11$ μs. 0.44 μs divides by γ; 5.0 is γ itself.

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PREVIEW

That’s the end of the preview answers

These are the answers to the 18 preview questions. The full answer key covers all 35 questions in Physics Unit 3 & 4 — Practice Exam 1, with the working behind every mark.

STILL TO COME	QUESTIONS	MARKS
Section A — multiple choice	2	2
Section B — short answer	15	100

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