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Physics, 2014 EC, natural science, entrance exam

Grade 12 · Physics · 2014 E.C.

MARKING KEY — CONFIDENTIAL

Time allowed: 120 minutes | **Questions:** 30 | **Total marks:** 30

1. Which of the following statements does NOT describe coherent light or interference of coherent light? (1)

A. Coherent light waves have the same frequency and wavelength.

B. In order for two waves to be coherent, they must be the same type of wave.

C. ✓ **Sustainable interference pattern can be formed by two waves with variable phase difference.**

D. Two waves which maintain a constant phase relationship can produce sustained interference.

Answer: C

Two light sources are coherent when they give out the same type of wave, with the same frequency and wavelength, and keep a constant phase difference between them. Only coherent sources can produce a steady, sustained interference pattern.

Check each choice. A is a correct description: coherent waves share one frequency and one wavelength. B is correct: the two waves must be the same type of wave. D is also correct: keeping a constant phase relationship is exactly what allows sustained interference. C is the false statement. If the phase difference keeps changing, the bright and dark positions shift all the time, so no sustained pattern can form.

The question asks for the statement that does NOT describe coherent light, so the answer is C.

Textbook: Physics Grade 10, Unit 6 Electromagnetic wave and geometrical optics, section 6.3 Light as a wave (page 161).

2. Kirchhoffs junction rule is a consequence of conservation of (1)

A. electrical energy.

B. ✓ **charge.**

C. mass.

D. momentum.

Answer: B

At a junction in a circuit, charge cannot pile up or disappear. Whatever charge flows into the junction each second must flow out in that same second. Kirchhoff's junction rule says the sum of currents entering a junction equals the sum of currents leaving it, and that is conservation of electric charge written for a circuit. The answer is B.

Conservation of energy is the basis of Kirchhoff's other rule, the loop rule, so option A points at the wrong rule.

Textbook: Physics Grade 11, Unit 6 Electrostatics and Electric Circuit.

3. Which one of the following statements describes the photoelectric effect interaction of radiation with matter? (1)

A. The intensity of radiation incident on a material can affect the energy of photoelectrons emitted from the metal surface.

B. In photoelectric effect, the photoelectron energy is directly proportional to the wavelength of incident radiation.

C. Any value of energy of photons (radiations) is capable of producing photoelectrons from a metal.

D. ✓ **When radiation of certain frequency f, interact with atoms of a material, electrons will be emitted with energies proportional to the radiation energy.**

Answer: D

In the photoelectric effect, light of frequency f arrives as photons, each carrying energy $E = hf$. One photon can free one electron from the metal. The maximum kinetic energy of that electron is $KE_{max} = hf - \phi$, where ϕ is the work function of the metal. So a higher photon energy gives more energetic photoelectrons, which is what option D says.

Why the others fail. A: intensity changes only the number of electrons emitted, never their energy. B: electron energy rises with frequency, and frequency is inversely related to wavelength, so energy is not proportional to wavelength. C: photons with energy below the work function release no electrons at all, however many arrive.

4. An object is placed 25.0 cm in front of a concave mirror having focal length of 10.0 cm. The magnification Of the mirror is (1)

A. 2.5

B. 16.7

C. ✓ **0.67**

D. 1.5

Answer: C

Use the mirror equation $\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$ with object distance $d_o = 25.0$ cm and focal length $f = 10.0$ cm.

$\frac{1}{d_i} = \frac{1}{10} - \frac{1}{25} = \frac{5-2}{50} = \frac{3}{50}$, so the image distance is $d_i = \frac{50}{3} \approx 16.7$ cm.

The magnification is $m = -\frac{d_i}{d_o} = -\frac{16.7}{25.0} \approx -0.67$. The minus sign only tells us the image is inverted; its size is 0.67 times the object, option C.

Option B is the image distance in cm, not the magnification, which is the tempting slip here.

Textbook: Physics Grade 10, Unit 6 Electromagnetic wave and geometrical optics, section 6.5 Mirrors and Lenses (page 174).

5. Which of the following statements distinguishes between random and systematic errors? (1)

A. Systematic error can be minimized by taking several readings and averaging; where as random error cannot be minimized.

B. ✓ **Systematic error makes measured values to be always above or always below the true value; whereas random error causes measured vales to be sometimes above and sometimes below the true value.**

C. Random error makes measured values to be always above or always below the true value; whereas systematic error causes measured values to be sometimes above and sometimes below the true value.

D. Random error makes measured values to be always above or always below the true value; whereas systematic error causes measured values to be sometimes above and sometimes below the true value.

Answer: B

A systematic error shifts every reading the same way. A wrongly zeroed scale, for example, makes all readings too high or all too low, so the measured values sit on one side of the true value. A random error changes unpredictably from reading to reading, so the values scatter, sometimes above and sometimes below the true value. That is exactly what option B states.

Option A swaps the cures: averaging many readings reduces random error, and it cannot remove a systematic error because the same bias sits in every reading. Options C and D both swap the two definitions, so they are wrong.

Textbook: Physics Grade 9, Unit 2 Physical Quantities.

6. Which of the following pair of vectors are collinear? (1)

A. 2i + 3j and -4i + 6j

B. 2i - 3j and -4i - j

C. ✓ **2i + 3j and -4i - 6j**

D. i + j and -i + j

Answer: C

Two vectors are collinear when they lie along the same line. That happens when one is a scalar multiple of the other, so their components keep one common ratio.

Test option C: multiply $2\vec{i} + 3\vec{j}$ by -2 and you get exactly $-4\vec{i} - 6\vec{j}$. The component ratios agree: $\frac{-4}{2} = \frac{-6}{3} = -2$. So this pair is collinear (parallel, pointing in opposite directions).

The other pairs fail the ratio test. In option A, for example, $\frac{-4}{2} = -2$ but $\frac{6}{3} = +2$, so those two vectors point along different lines.

Textbook: Physics Grade 11, Unit 2 Vectors, section 2.1 Vectors and Types of Vectors (page 17).

7. For an object moving in straight line, (1)

A. If the displacement changes by equal amount in equal time interval, the displacement-time graph is horizontal line.

B. The area of the region under the displacement-time graph and the slope of velocity-time graph are, respectively, the acceleration and displacement of the object.

C. ✓ **If the velocity increases by equal amount in equal time interval, the velocity -time graph is straight line with positive slope and the acceleration-time graph is horizontal.**

D. The slope of displacement-time graph and the area of the region under acceleration-time graph are, respectively, the acceleration and velocity Of the object.

> **Answer:** C
>
> Velocity increasing by equal amounts in equal time intervals means constant acceleration. With constant acceleration, the velocity time graph is a straight line with positive slope, and the acceleration time graph is a horizontal line at one fixed value. That is option C.
>
> The others mix up the graph rules. A: equal displacement in equal times is constant velocity, so the displacement time graph is a sloped straight line, not a horizontal one. B and D: the slope of a displacement time graph gives velocity (not acceleration), the slope of a velocity time graph gives acceleration, and the area under an acceleration time graph gives the change in velocity.
>
> **Textbook:** Physics Grade 11, Unit 3 Motion in one and two dimensions, section 3.3 Graphical Representation of Uniformly accelerated Motion in 1D (page 60).

8. Which of the following is true about satellite motion? (1)

A. A satellite moving closer to the Earth takes longer time to complete one revolution than a satellite farther from the Earth.

B. For two satellites moving around the Earth at equal orbital radius, a heavier satellite has larger speed than a lighter one.

C. For equal orbital radius, a satellite moving around the Earth has smaller speed than a satellite moving about moon.

D. ✓ **A satellite closer to Earth is faster than a satellite farther from the Earth.**

> **Answer:** D
>
> For a satellite in a circular orbit, gravity supplies the centripetal force: $\frac{GMm}{r^2} = \frac{mv^2}{r}$. Solving gives $v = \sqrt{\frac{GM}{r}}$.
>
> The speed depends only on the mass M of the body being orbited and the orbital radius r. A smaller r gives a larger v, so a satellite closer to the Earth moves faster. That is option D.
>
> A fails because a closer satellite is faster and travels a shorter orbit, so its period is shorter, not longer. B fails because the satellite's own mass m cancels out of the equation. C fails because the Earth is far more massive than the Moon, so at the same orbital radius a satellite of the Earth moves faster, not slower.
>
> **Textbook:** Physics Grade 12, Unit 2 Two-dimensional motion, section 2.5 Newton's law of universal Gravitation (page 59).

9. According to the work- energy theorem, (1)

A. work done by tension on an object tied to a string and moving a horizontal circle is negative.

B. work done by gravity on an object downward is negative.

C. ✓ **work done by gravity on an object thrown upward and moving upward is negative.**

D. work done by gravitational force on a satellite moving around the earth in a circular is positive.

Answer: C

Work is $W = Fd\cos\theta$, where θ is the angle between the force and the displacement. Work is positive when the force helps the motion, negative when it opposes the motion, and zero when the force is perpendicular to the motion.

For a ball thrown upward and still moving upward, gravity pulls down while the displacement points up, so $\theta = 180^\circ$ and the work done by gravity is negative. Option C is correct.

A and D describe forces that stay perpendicular to the motion (tension in a horizontal circle, gravity on a satellite in a circular orbit), so their work is zero, not negative or positive. B is wrong because gravity does positive work on an object moving downward: force and displacement point the same way.

Textbook: Physics Grade 11, Unit 4 Dynamics, section 4.4 Work, Energy and Power (page 128).

10. A young double slit experiment consists of two narrow slits separated by 0.06 mm and 1.2 m away from a screen. If the slits are illuminated with a light of wavelength 563 nm, the location of the fourth bright fringe on the screen is (1)

A. 0.394 cm

B. 0.45 cm

C. 3.94 cm

D. ✓ **4.5 cm**

Answer: D

In a double slit experiment, the m-th bright fringe sits a distance $y_m = \frac{m\lambda L}{d}$ from the center of the screen.

Here $m = 4$, $\lambda = 563 \times 10^{-9}$ m, $L = 1.2$ m, and $d = 0.06$ mm $= 6 \times 10^{-5}$ m.

$$y_4 = \frac{4 \times 563 \times 10^{-9} \times 1.2}{6 \times 10^{-5}} = 0.045 \text{ m} = 4.5 \text{ cm}$$

The fourth bright fringe is 4.5 cm from the central bright fringe, option D. Option B (0.45 cm) comes from slipping one power of ten in the unit conversions, so write every quantity in metres before dividing.

Textbook: Physics Grade 10, Unit 6 Electromagnetic wave and geometrical optics, section 6.3 Light as a wave (page 161).

11. An electric dipole consists of a negative charge —q placed at a point with 'x' and 'y' coordinates (—2, —2) and a positive charge +q at (2, 2). The dipole is placed in a uniform electric field directed 'E' in the positive direction. If the dipole axis makes an angle θ nith the field, which of the following is true about the dipole? (1)

A. ✓ **The field rotates the dipole in the direction of decreasing the angle θ, until the dipole becomes parallel to the field.**

B. The field rotates it in the direction of increasing the angle θ, until the dipole is perpendicular to the filed.

C. It is in both translational and rotational equilibrium.

D. It travels in the direction of the electric field.

Answer: A

The negative charge sits at (-2, -2) and the positive charge at (2, 2), so the dipole moment $\vec{p}$ points from the negative charge toward the positive charge, at an angle θ to the field $\vec{E}$.

In a uniform field, the forces on the two charges are equal in size and opposite in direction, so the net force is zero and the dipole does not travel anywhere. But the two forces form a couple with torque $\tau = pE\sin\theta$. This torque turns the dipole so that θ shrinks, and it dies away as the dipole lines up parallel to the field, where $\sin\theta = 0$. That is option A.

B has the rotation backwards: perpendicular is the position of maximum torque, not rest. C fails because the dipole is not in rotational equilibrium while θ is not zero. D fails because the net force in a uniform field is zero, so the dipole does not travel along the field.

Textbook: Physics Grade 11, Unit 6 Electrostatics and Electric Circuit, section 6.2 Electric Fields (page 225).

12. The electric potential at a distance of 2 cm from -1.6 change is (1)

A. 4.4V

B. ✓ **-720V**

C. -14.4V

D. 720V

Answer: B

The charge in the original paper is -1.6 nC, which is -1.6×10^{-9} C. (The unit was lost when this question was copied.) The potential of a point charge is $V = \frac{kQ}{r}$, with $k = 9 \times 10^9$ N m^2/C^2 and $r = 2$ cm $= 0.02$ m.

$$V = \frac{9 \times 10^9 \times (-1.6 \times 10^{-9})}{0.02} = \frac{-14.4}{0.02} = -720 \text{ V}$$

The potential is negative because the charge is negative, so the answer is B. Option C (-14.4 V) is what you get if you forget to divide by the distance.

Textbook: Physics Grade 11, Unit 6 Electrostatics and Electric Circuit, section 6.3 Electric Potential (page 232).

13. Consider a long and tightly wound solen ind length L and N turghtly wound solenoid carrying current I, having length, which of the following describes the magnetic field produced by the solenoid? (1)

A. The magnetic field inside the solenoid is zero, whereas the field outside is perpendicular to the length of the solenoid.

B. ✓ **The magnetic field inside the solenoid is constant and is parallel to the solenoid's axis, whereas the field outside is negligible.**

C. The magnetic field inside the solenoid is uniform and perpendicular to the axis of the solenoid.

D. The magnetic field outside the solenoid is as strong as the field inside it.

Answer: B

The question asks about the magnetic field of a long, tightly wound solenoid of length L with N turns carrying current I. Inside such a solenoid, the field is nearly uniform, runs parallel to the axis of the solenoid, and has magnitude $B = \mu_0 \frac{N}{L} I$. Outside, the fields of the individual turns nearly cancel, so the external field is negligible. That is option B.

A and D reverse the inside and outside strengths: the field is concentrated inside, not outside. C gives the wrong direction: the inside field runs along the axis, not across it.

Textbook: Physics Grade 12, Unit 4 Electromagnetism, section 4.3 Current and Magnetism (page 122).

14. According to the law of electromagnetic induction, (1)

A. ✓ **the magnitude of emf induced in a circuit is directly proportional to the rate of change the magnetic flux crossing any surface bounded by the circuit.**

B. a changing magnetic field parallel to the plane of a circuit induces an emf in it.

C. a constant magnetic flux crossing the surface of a circuit induced an emf in the circuit.

D. an emf is induced in a circuit when a constant magnetic field crosses its surface.

Answer: A

Faraday's law says an emf appears in a circuit only when the magnetic flux through the circuit changes, and the size of the emf equals the rate of change of that flux: $\varepsilon = -\frac{\Delta\Phi}{\Delta t}$. Option A states exactly this.

B fails because a field parallel to the plane of the circuit sends no flux through the circuit at all, so changing it induces nothing. C and D fail because a constant flux, or a constant field, means $\Delta\Phi = 0$, and with no change there is no induced emf.

Textbook: Physics Grade 12, Unit 4 Electromagnetism, section 4.5 Faraday's Law of electromagnetic Induction (page 129).

15. According to the Heisenberg's uncertainty principle,T (1)

A. the larger the position uncertainty, the larger the momentum uncetainty.

B. if the uncertainty in position decreases, the momentum uncertainty decreases, too.

C. ✓ **the more precisely we measure the position of a particle; we become less precise of its momentum and vice versa.**

D. we can measure both the position and momentum Of a particle simultaneously with unlimited precision.

> **Answer:** C
> Heisenberg's uncertainty principle sets a floor under the product of the position uncertainty and the momentum uncertainty: $\Delta x\, \Delta p \geq \frac{h}{4\pi}$. Because the product can never fall below this limit, squeezing one uncertainty forces the other to grow.
>
> So measuring position more precisely (smaller Δx) makes the momentum less certain (larger Δp), and the other way round. That is option C.
>
> A and B claim the two uncertainties rise and fall together, which would let their product shrink toward zero and breaks the rule. D claims unlimited precision for both at once, which is exactly what the principle forbids.

16. The graph of nuclear binding energy per nucleon (BE/A) versus mass number (A) has its peak near an atomic weight A = 56. Which of the following statements is true about the graph? (1)

A. Uranium (A = 235), which has larger binding energy than iron 56), is more stable than iron.

B. Nucleus with larger number of neutron is more stable than nucleus of the same atom with smaller number of neutron.

C. ✓ **For heavier nuclei (A > 56), the binding energy per nucleon decreases with the increase of mass number; implying that heavier atoms can increase their stabili b increasin their roton's number.**

D. For smaller atoms (A < 56), the biding energy per nucleon generally increases with the increase of mass number; indicating that lighter atoms can increase stability through nuclear fission.

> **Answer:** C
> The binding energy per nucleon curve rises steeply for light nuclei, peaks near iron ($A = 56$), then falls slowly as A grows. A higher binding energy per nucleon means a more stable nucleus.
>
> For heavy nuclei ($A > 56$), the binding energy per nucleon drops as the mass number rises. A heavy nucleus can therefore become more stable by breaking into smaller pieces, which is why fission of heavy nuclei such as uranium releases energy. Option C carries this idea; note that its printed text was damaged in copying, but its first clause is the standard true statement.
>
> A is wrong: uranium has a larger total binding energy only because it holds many more nucleons; its binding energy per nucleon is lower than iron's, so it is less stable. B is wrong: stability depends on the balance between protons and neutrons, not simply on having more neutrons. D is wrong: light nuclei ($A < 56$) gain stability through fusion, not fission.
>
> **Textbook:** Physics Grade 11, Unit 7 Nuclear Physics.

17. Which of the following statements is NOT correct about reflection and refraction of sound waves and their applications? (1)

A. In pre-natal scanning, reflection and refiraction of sound allows doctors to monitor the progress of a developing baby.

B. ✓ **Reflection of sound (echo) is formed when sound enters a medium of varying densities.**

C. Reflection and refiraction of sound are used to detect flaws in metals and to help people park their cars.

D. Refraction of sound is the change in its direction as it travels through a medium having different densities.

Answer: B

An echo is sound bouncing back from a boundary or an obstacle, such as a wall or a cliff. Reflection happens at the surface between two media. It is not caused by sound entering a medium whose density varies; a direction change while passing through regions of different density is refraction. So option B mixes the two ideas and is the incorrect statement, which is what the question asks for.

The other three are correct. Ultrasound scans use reflected and refracted sound to follow a developing baby (A). Reflected pulses locate flaws inside metals and drive car parking sensors (C). Refraction is the bending of sound as it travels through media of different densities (D).

Textbook: Physics Grade 9, Unit 6 Mechanical Oscillation and Sound Wave, section 6.6 Characteristics of Sound Waves (page 132).

18. A torque τ rotates an object of mass m and moment of inertia I through an angle θ. The work done on the object by the torque is (1)

A. Iθ

B. mθ

C. ✓ **τθ**

D. τI

Answer: C

In rotation, torque plays the role that force plays in straight line motion, and the angle turned plays the role of distance. So the work done by a constant torque is $W = \tau\theta$, the rotational twin of $W = Fd$. The answer is C.

The mass and the moment of inertia do not enter the work formula. The moment of inertia I decides how quickly the object speeds up under the torque, through $\tau = I\alpha$, not how much work the torque does over the angle θ.

Textbook: Physics Grade 12, Unit 2 Two-dimensional motion, section 2.3 Rotational Dynamics (page 50).

19. A satellite revolves around the earth in a circular orbit of radius r = 4 x 10^{16} m. The period of the satellite is (1)

A. 2.5 x 10^(19) s

B. 3.7 x 10^(26) s

C. 3.7 x 10^(27) s

D. ✓ **2.5 x 10^(18) s**

Answer: D

For a circular orbit, Kepler's third law in Newton's form gives $T = 2\pi\sqrt{\frac{r^3}{GM}}$. For the Earth, $GM = 6.67 \times 10^{-11} \times 5.98 \times 10^{24} \approx 4.0 \times 10^{14}$ m^3/s^2.

First cube the radius: $r^3 = (4 \times 10^{16})^3 = 6.4 \times 10^{49}$ m^3.

Then $\frac{r^3}{GM} = \frac{6.4\times10^{49}}{4.0\times10^{14}} = 1.6 \times 10^{35}$ s^2, and the square root is 4.0×10^{17} s.

Finally $T = 2\pi \times 4.0 \times 10^{17} \approx 2.5 \times 10^{18}$ s, option D. Option A comes from the same working with a slipped power of ten, so track the exponents carefully.

Textbook: Physics Grade 12, Unit 2 Two-dimensional motion, section 2.4 Planetary motion and Kepler's laws (page 54).

20. One of the following statements is a correct description of the charging processes? (1)

A. During charging a neutral object by induction using a negatively charged rod, charge flows from the rod to the object.

B. When a neutral metallic sphere is charged by induction using a negatively charged rod, the sphere acquires a net negative charge.

C. ✓ **When a positively charged object is momentarily brought into contact with a neutral metallic sphere. the sphere acquires a net positive charge.**

D. When a plastic rod is rubbed with wool, the two objects acquire a net charge of the same region.

> **Answer:** C
> Charging by contact transfers charge directly. When a positively charged object touches a neutral metallic sphere, electrons flow from the sphere onto the object. The sphere is left short of electrons, so it ends up with a net positive charge, the same sign as the charging object. Option C is correct.
>
> A fails because in charging by induction the rod never touches the object, so no charge flows from the rod; the object's own charges just rearrange. B fails because induction leaves the sphere with the opposite sign: a negative rod drives electrons away through the ground connection, so the sphere ends up positive. D fails because rubbing gives the two objects charges of opposite signs, since electrons move from one onto the other.
>
> **Textbook:** Physics Grade 10, Unit 4 Static and Current Electricity, section 4.2 Methods of Charging a Body (page 84).

21. A parallel plate capacitor is charged with a battery. The battery is thenm disconnected, and a dielectric material is inserted between the plates of the capacitor. Which of the following is correct about the effect of the dielectric? (1)

A. The potential difference between the plates remains the energy stored increases.

B. The charge on the plates decreases and the energy stored increases.

C. ✓ **The electric field between the plates and the energy stored decrease.**

D. The capacitance remains the same and the electric field between the plates increases.

> **Answer:** C
> Once the battery is disconnected, the charge Q on the plates is trapped; it has nowhere to go. Inserting a dielectric of constant κ raises the capacitance from C to κC.
>
> With Q fixed, follow the consequences. The voltage drops to $V = \frac{Q}{\kappa C}$. The field between the plates drops too, since the polarized dielectric partly cancels it. The stored energy drops to $U = \frac{Q^2}{2\kappa C}$. Both the field and the energy decrease, which is option C.
>
> The energy goes down because the capacitor pulls the dielectric inward and does work on it as it enters. B fails because the charge cannot change with the battery removed. A and D fail because the voltage and the field both decrease while the capacitance increases.
>
> **Textbook:** Physics Grade 11, Unit 6 Electrostatics and Electric Circuit, section 6.6 Capacitors and Capacitance (page 270).

22. Which one of the following statements is correct about the resistance of a conductor with a circular cross-section? (1)

A. At a given temperature, the resistance of copper and silver wires of them same length and diameter is the same.

B. ✓ **The resistance of the conductor increases as its length increases and its diameter decreases.**

C. The resistance of the conductor increases as its length and diameter increases.

D. The resistance of the conductor decreases as it is heated.

> **Answer:** B
>
> The resistance of a wire is $R = \frac{\rho L}{A}$, and for a circular cross-section the area is $A = \frac{\pi d^2}{4}$.
>
> So resistance grows with length and shrinks as the wire gets thicker. A longer wire with a smaller diameter therefore has more resistance, which is option B.
>
> A fails because copper and silver have different resistivities ρ, so wires of equal size still have different resistances. C fails because a larger diameter lowers resistance instead of raising it. D fails because heating a metal conductor raises its resistance: the vibrating lattice scatters the moving electrons more strongly.
>
> **Textbook:** Physics Grade 11, Unit 6 Electrostatics and Electric Circuit, section 6.4 Electric Current, Resistance and ohm's law (page 240).

23. The primary coil of a transformer has 250 turns and its secondary coil consists of 1500 turns. If 220 V is applied to its primary coil, the voltage induced in the secondary coil, respectively, are (1)

A. ✓ **1320 V and 6**

B. 1330 V and 60

C. 1330 V and 6

D. 1320 V and 60

> **Answer:** A
>
> The options pair two numbers: the secondary voltage and the turns ratio.
>
> The turns ratio is $\frac{N_s}{N_p} = \frac{1500}{250} = 6$, so this is a step-up transformer.
>
> For an ideal transformer, $\frac{V_s}{V_p} = \frac{N_s}{N_p}$. So $V_s = 220 \times 6 = 1320$ V.
>
> The pair 1320 V and 6 is option A. Since 220×6 is exactly 1320, the 1330 V choices come from an arithmetic slip.
>
> **Textbook:** Physics Grade 12, Unit 4 Electromagnetism, section 4.6 Transformers (page 131).

24. A diode is an electronic component thatR (1)

A. is useful to covert a DC voltage to AC voltage,

B. ✓ **allows electric current to pass through it in one direction.**

C. allows the flow of current when its p-type region is connected to the negative terminal of a cell.

D. allows current to mass through it either from cathode to anode or from anode to cathode.

> **Answer:** B
>
> A diode conducts easily in one direction only. Current flows when the diode is forward biased, that is, when its p-type side (the anode) is connected to the positive terminal of the cell. Reversing the connection blocks the current. Option B states this defining property.
>
> A fails because a diode is used to help turn AC into DC (rectification), not DC into AC. C fails because connecting the p-type region to the negative terminal is reverse bias, which stops the current. D fails because conduction in both directions is exactly what a diode does not allow.
>
> **Textbook:** Physics Grade 12, Unit 5 Basics of electronics, section 5.2 Diodes and their Functions (page 147).

25. A student throws a ball vertically upward with a speed of 20 m/s. The maximum height reached by the ball and its velocity 30 s after it was thrown aret respectively (1)

A. 20 m and 30 m/s upward

B. 105 m and 50 m/s upward.

C. 15 and 10 m/s downward.

D. ✓ **20 and 10 m/s downward.**

Answer: D

Take $g = 10$ m/s^2 and up as positive. Note that the time in the stem should read 3 s; the options only work for 3 s, so the printed 30 s is a misprint.

Maximum height: at the top the velocity is zero, so $v^2 = u^2 - 2gh$ gives $0 = 20^2 - 2 \times 10 \times h$, so $h = \frac{400}{20} = 20$ m.

Velocity after 3 s: $v = u - gt = 20 - 10 \times 3 = -10$ m/s. The minus sign means the ball is moving downward at 10 m/s. It makes sense: the ball rises for 2 s, then falls for the remaining 1 s.

So the pair is 20 m and 10 m/s downward, option D.

Textbook: Physics Grade 11, Unit 3 Motion in one and two dimensions, section 3.4 Vertical Motion (page 70).

26. Which one of the following statements describes the difference between different types of friction? (1)

A. ✓ **For an object at rest on a horizontal surface, static friction increases with the increase of the applied force and reaches a maximum value just before slidin occurs.**

B. Limiting friction is the minimum value Of static friction that keeps an object stationary.

C. If there is a constant force applied to a stationary object on a horizontal surface, the static friction becomes equal to the limiting friction.

D. Limiting and kinetic frictions exist at the same time between two surfaces sliding over each other.

Answer: A

While an object stays at rest, static friction is a responsive force: it matches the applied force and grows as the push grows. It can grow only up to a maximum value called the limiting friction. Push harder than that and the object starts to slide. Option A describes this correctly.

B fails because limiting friction is the maximum of static friction, not the minimum. C fails because static friction equals the limiting value only at the point of slipping, not for just any constant applied force. D fails because limiting (static) friction and kinetic friction never act together: once sliding begins, only kinetic friction acts between the surfaces.

Textbook: Physics Grade 11, Unit 4 Dynamics, section 4.2 Frictional Force (page 112).

27. The apparent weight of a 60 kg student standing inside a lift is (1)

A. 600 N when the lift accelerates with acceleration equal to gravilational acceleration.

B. 600 N when the lift accelerates upward with 2 m/s^2.

C. ✓ **480 N when the lift accelerates downward with 2 m/s^2.**

D. 720 N when the lift is at rest.

Answer: C

Apparent weight is the normal force N the lift floor pushes up with. Newton's second law on the student gives $N = m(g + a)$ when the lift accelerates upward and $N = m(g - a)$ when it accelerates downward. Take $g = 10$ m/s^2 and $m = 60$ kg.

Check option C: accelerating downward at 2 m/s^2 gives $N = 60 \times (10 - 2) = 480$ N. Correct.

The others fail. A: accelerating downward at $a = g$ is free fall, so $N = 0$, not 600 N. B: accelerating upward at 2 m/s^2 gives $60 \times 12 = 720$ N, not 600 N. D: at rest, $N = mg = 600$ N, not 720 N.

Textbook: Physics Grade 11, Unit 4 Dynamics, section 4.1 The Concept of Force and Newton's Laws of motion (page 96).

28. Which of the following statements describe the use of energy resources? (1)

A. ✓ **Solar energy produced by photovoltaic cells in free of greenhouse gases and has a very low running cost.**

B. Hydroelectric power generates a large amount of energy using small dam with little environmental impact and cheap initial cost of construction.

C. Geothermal energy is the most accessible, environmental friendly and inexpensive source of energy.

D. Wind energy, which is due to the pressure difference in space as the result of uneven sun heat, is a consistent and economical source of energy. Wind energy, which is due to the pressure difference in space as the result of uneven sun heat, is a consistent and economical source of energy.

Answer: A

Photovoltaic cells turn sunlight directly into electricity. They burn no fuel, so they release no greenhouse gases while running, and once installed their running cost is very low because sunshine is free. Option A is the accurate statement.

B fails twice: producing a large amount of hydroelectric power needs a large dam, and big dams are expensive to build and flood wide areas, so the environmental impact is not small. C overstates geothermal energy: it is clean, but it is only accessible where the geology is right, and drilling is costly. D fails because wind comes from pressure differences in the atmosphere caused by uneven heating of the Earth's surface by the sun, not from pressure differences in space, and wind is variable rather than consistent.

29. According to the law of floatation, an object must displaces a volume of fluid (1)

A. equal to the weight of undisplaced fluid.

B. equal to its apparent weight.

C. less than its own weight.

D. ✓ **equals to its own weight.**

Answer: D

The law of flotation follows from Archimedes' principle. A floating object is in balance: the upward buoyant force equals the object's weight. The buoyant force itself equals the weight of the fluid the object displaces. Putting the two together, a floating object displaces fluid whose weight equals the object's own weight. That is option D.

C describes a sinking object: if the displaced fluid weighs less than the object even when it is fully under, the object goes down. B is wrong because a floating object's apparent weight is zero, so it says nothing useful. A refers to undisplaced fluid, which has no role in the balance.

Textbook: Physics Grade 12, Unit 3 Fluid Mechanics, section 3.3 Archimedes' principle (page 96).

30. Which one of the following statements describes the unusual behavior of expansion of water? (1)

A. The density of water at 0?C is less than its density at 4?C, since water molecules move further apart
✓ **and form a second hydrogen bond with other water molecules.**

B. As a temperature of water increases above 4?C, its density increases since water molecules move further apart to form a second hydrogen bond with other molecules.

C. At 0?C, water has larger density and smaller volume than its density and volume at 4?C.

D. As a temperature of water increases from 0?c to 4?c, its density increases since one molecule of water forms one hydrogen bond with another molecule

Answer: A

Most liquids expand steadily when heated, but water behaves unusually between 0 and 4 degrees Celsius. Water is densest at 4 degrees Celsius. Cooling it below 4 degrees makes it expand: the molecules settle into a more open, hydrogen-bonded arrangement and sit slightly further apart. So at 0 degrees Celsius water is less dense than at 4 degrees Celsius, which is what option A says.

B has the trend backwards: above 4 degrees Celsius, warming water lowers its density like a normal liquid. C reverses the facts: at 0 degrees Celsius the density is smaller and the volume larger than at 4 degrees Celsius. D states the right density trend from 0 to 4 degrees Celsius but gives a wrong reason for it.

This anomaly is why ice floats and why ponds freeze from the top down while fish survive below.

Textbook: Physics Grade 11, Unit 5 Heat Conduction and Calorimetry, section 5.4 Thermal expansion (page 186).

— END OF MARKING KEY —