Grade 12 Physics Model Paper 2

MODEL PAPER

Full marks 75 · 3 hours

Name _____ Class _____ Roll no. ____ Date _____ Marks _____ / 75

Answer every question; where a question has an OR question, answer either one. Time: 3 hours.

A practice paper by Science Playground, made to CDC's Specification Grid 2078, Grade 12 Physics (Phy. 102); not an official CDC or NEB paper. Mark it yourself online: the QR code below opens the paper with its answers.

A full practice run of the NEB Grade 12 Physics paper (Phy. 102): 75 marks in 3 hours, 12 questions in three groups. Group A is one question of 11 multiple-choice items, about 25 minutes; groups B and C have short- and long-answer questions of two to four parts, with each part's marks shown. Questions 3 and 9 in group B and Questions 10 and 12 in group C each have an OR question: answer either the question or its OR question, every part from the same one, and mark only the one you answered. Write on paper first, then tap your choice in group A and open each other part's answer to give yourself the marks its scheme allows. Where needed, take $g = 9.8$ m/s², $h = 6.62 \times 10^{-34}$ J s, $c = 3 \times 10^{8}$ m/s, $e = 1.6 \times 10^{-19}$ C and the electron's mass $m_e = 9.1 \times 10^{-31}$ kg.

Group A Multiple choice — 11 marks

Question 1 — 11 × 1 = 11

Choose the correct option for each of the following questions.

a. What is the SI unit of the coefficient of viscosity?

(i) N/m (ii) Pa s (N s/m²) (iii) N/m² (iv) m²/s

b. The flywheel of an engine is made with most of its mass in a heavy rim. Why?

(i) to make it lighter for the same size

(ii) to give it a large moment of inertia, so that its speed changes little between the engine's strokes

(iii) to reduce the friction at its axle

(iv) to make its angular momentum zero

c. Water flows at 2 m/s along a hose of cross-section 4 cm² and leaves through a nozzle of cross-section 1 cm². At what speed does it leave the nozzle?

(i) 0.5 m/s (ii) 2 m/s (iii) 4 m/s (iv) 8 m/s

d. A block of ice melts to water at 0 °C, taking in heat while its temperature stays the same. What happens to its entropy?

(i) It stays the same, because the temperature does not change.

(ii) It increases, because it takes in heat and its molecules become less ordered.

(iii) It decreases, because water is denser than ice.

(iv) It becomes zero, because 0 °C is the melting point.

e. A gas in a cylinder expands at a constant pressure of 2×10^5 Pa, and its volume increases by 3×10^{-3} m³. How much work does the gas do?

(i) 60 J (ii) 600 J (iii) 6,000 J (iv) 6.7×10^7 J

f. On a hot afternoon sound travels faster in Birgunj than it does in the same town on a cold morning. Which of these explains it?

(i) The air pressure is higher in the afternoon.

(ii) The air is denser when it is hot.

(iii) The speed of sound in a gas is proportional to the square root of its absolute temperature.

(iv) Sound waves have a higher frequency in hot air.

g. Two polaroids are crossed, so no light passes through them. A third polaroid is placed between them with its axis at 45° to both. What fraction of the unpolarized light falling on the first polaroid now comes out of the last?

(i) none (ii) one eighth (iii) one quarter (iv) one half

h. Why is soft iron, not steel, used for the core of a transformer?

(i) Soft iron has a larger retentivity and coercivity.
(ii) Soft iron has a narrow hysteresis loop, so little energy is lost in each cycle of magnetization.
(iii) Soft iron is diamagnetic, so it repels the flux.
(iv) Steel cannot be magnetized at all.

i. Two long, straight, parallel wires carry currents in the same direction. What happens to them?

(i) They attract each other.
(ii) They repel each other.
(iii) They feel no force, as the currents are equal.
(iv) They twist to lie at right angles to each other.

j. A metal rod 0.5 m long moves at 4 m/s at right angles to a uniform magnetic field of 0.2 T, with the rod at right angles to both the field and its motion. What e.m.f. is induced between its ends?

(i) 0.025 V (ii) 0.1 V (iii) 0.4 V (iv) 1.6 V

k. What did Millikan's oil drop experiment show about electric charge?

(i) that the electron's charge is negative
(ii) that every charge is a whole-number multiple of a smallest charge, e
(iii) that charge can be created and destroyed
(iv) that the charge of an electron depends on its speed

Group B Short answers, each on one content area — 40 marks

Question 2 — 5 marks

In a laboratory in Dhangadhi, water rises 3.0 cm up a clean glass capillary tube dipped in a beaker of water.

a. Define surface tension. **[1]**

b. Explain why small drops of rain and of mercury are nearly spherical. **[2]**

c. Rabina puts a second tube of the same glass, with half the bore radius, into the water so that only 2.0 cm of it sticks out above the surface. She expects water to overflow from its top like a fountain. Is she right? Explain. **[2]**

Question 3 — 5 marks

A block of mass 0.50 kg on a spring of force constant 50 N/m slides back and forth on a smooth horizontal track with an amplitude of 0.10 m.

a. What is meant by resonance? **[1]**

b. Calculate the period of the oscillation and the block's greatest speed. **[2]**

c. Kushal says the block's kinetic energy equals its potential energy halfway between the mean position and the end, at 5 cm. Is he right? Find where the two energies are equal. **[2]**

OR

A flywheel with a moment of inertia of 2.0 kg m² starts from rest and is turned by a steady torque of 10 N m.

a. Define moment of inertia. **[1]**

b. Calculate its angular acceleration and its rotational kinetic energy after 4.0 s. **[2]**

c. A potter's wheel in Bhaktapur is spinning freely when the potter drops a lump of clay onto its center. What happens to its angular velocity and to its kinetic energy? Justify your answer. **[2]**

Question 4 — 5 marks

A freezer keeps its inside at −13 °C in a kitchen at 27 °C.

a. State the Kelvin–Planck statement of the second law of thermodynamics. **[1]**

b. Explain why no heat engine can have an efficiency of 100%. **[2]**

c. Calculate the coefficient of performance of an ideal (Carnot) refrigerator working between these two temperatures. **[1]**

d. On a hot day, Prapti suggests leaving the freezer door open to cool the kitchen. Will it work? Give a reason. **[1]**

Question 5 — 5 marks

The light reflected from the surface of Phewa Lake on a sunny morning is partly polarized. For water, the refractive index is 1.33, and for crown glass 1.5.

a. State Brewster's law. **[1]**

b. Calculate the polarizing angle for crown glass, and the angle of refraction at that angle of incidence. **[2]**

c. Polaroid sunglasses cut the glare from the lake far better than ordinary dark glasses of the same darkness. Explain why, and say which way the polaroid's axis should point. **[2]**

Question 6 — 5 marks

In a velocity selector, a beam of protons passes through a region where a uniform electric field and a uniform magnetic field of 0.05 T are at right angles to each other and to the beam.

a. Define one tesla. **[1]**

b. Nischal wants the selector to pass only protons moving at 2.0×10^5 m/s. Find the electric field he needs, and explain how the selector lets protons of this speed through undeviated while slower and faster ones are turned aside. **[3]**

c. Would electrons with the same speed also pass straight through this selector? Justify your answer. **[1]**

Question 7 — 5 marks

Abinash makes an iron–copper thermocouple and keeps its cold junction in water at 20 °C. The neutral temperature of iron–copper is about 270 °C.

a. Define neutral temperature and temperature of inversion. **[2]**

b. Why does the neutral temperature not change when the cold junction is kept at a different temperature? **[1]**

c. Abinash heats the hot junction from 300 °C to 450 °C and finds the e.m.f. getting smaller. He thinks the thermocouple is damaged. Explain what is happening, and find the temperature at which its e.m.f. would become zero. **[2]**

Question 8 — 5 marks

An electron moving at 2.0×10^7 m/s enters a uniform magnetic field of 2.0 mT at right angles to the field.

a. Show that its path is a circle, and calculate the radius of the circle. **[3]**

b. If the electron's speed were doubled, what would happen to the radius of its circle and to the time it takes to go round once? Justify your answer. **[2]**

Question 9 — 5 marks

A seismograph station near Pokhara records an earthquake. The P waves travel at 6.0 km/s and the S waves at 3.5 km/s, and the first S waves arrive 20 s after the first P waves.

a. Write any three differences between P waves and S waves. **[3]**

b. How far is the station from the focus of the earthquake? **[2]**

OR

Light of wavelength 400 nm falls on a clean potassium surface, whose work function is 2.3 eV.

a. Write any three laws of photoelectric emission. **[3]**

b. Calculate the maximum kinetic energy of the photoelectrons in electron volts, and the stopping potential. **[2]**

Group C Long answers, each on one content area — 24 marks

Question 10 — 8 marks

A bus waiting at Kalanki sounds its horn of frequency 500 Hz. The speed of sound in the air is 340 m/s, and the threshold of hearing is $I_0 = 10^{-12}$ W/m².

a. At a pedestrian's ear the intensity of the horn's sound is 10^{-5} W/m². Calculate its intensity level in decibels. **[2]**

b. The bus then drives towards a stationary listener at 20 m/s, sounding its horn. Calculate the frequency she hears, and the frequency she hears after it has passed her and moves away at the same speed. **[2]**

c. The pedestrian of part a walks to twice her distance from the horn. Alina says the intensity level will fall to half, 35 dB. Is she right? Justify your answer. **[2]**

d. Would the listener hear the same change of pitch if the bus stood still and she rode towards it at 20 m/s? Justify your answer. **[2]**

OR

A wave traveling along a long rope is described by $y = 0.05\sin(200\pi t - 0.5\pi x)$, with x and y in meters and t in seconds.

a. Find the frequency and the wavelength of the wave. **[2]**

b. Find the speed of the wave and the greatest speed of a particle of the rope. **[2]**

c. What is the phase difference between two points of the rope 1.0 m apart along it? What does it mean for their motion? **[2]**

d. Swastika says the rope's particles are carried along by the wave at 400 m/s. Is she right? Justify your answer. **[2]**

Question 11 — 8 marks

A transformer at a substation in Hetauda steps the 11 kV of the distribution line down to 220 V for a row of houses. Its primary coil has 2,500 turns.

a. Explain the principle on which a transformer works. **[2]**

b. Explain why electricity is sent over long distances at a high voltage. **[2]**

c. Calculate the number of turns of the secondary coil, and the currents in the two coils when the houses draw 4.4 kW. Treat the transformer as ideal. **[2]**

d. Diya connects a small step-up transformer to a 12 V car battery, hoping to light a 220 V bulb. The bulb stays dark, except for a brief flash at the moment she connects the battery and again when she disconnects it. Explain both. **[2]**

Question 12 — 8 marks

A phone charger turns the 12 V (rms) a.c. from a small transformer into d.c. with a bridge rectifier of four silicon diodes.

a. Explain why a p–n junction diode conducts when it is forward biased but hardly at all when it is reverse biased. **[2]**

b. Explain how a bridge rectifier makes the current through the load flow in the same direction in both halves of each a.c. cycle. **[2]**

c. Calculate the peak voltage across the load, taking a drop of 0.7 V across each conducting silicon diode. **[2]**

d. The output of the rectifier rises and falls 100 times a second, and the phone needs a steady voltage, so a capacitor is connected across the load. Explain how it makes the voltage steadier, and whether the voltage would dip more or less between peaks if the phone drew a larger current. **[2]**

OR

Smriti measures the count rate of a radioactive sample with a Geiger–Müller counter every hour. Before she brings the sample in, the counter records a background count of 30 counts per minute.

Time (hours)	0	1	2	3	4
Count rate (counts per minute)	1630	1161	830	596	430

a. Explain why the number of nuclei that decay each second is proportional to the number of undecayed nuclei present. **[2]**

b. Explain why the mean life of a radioactive substance is longer than its half-life. **[2]**

c. Find the half-life of the sample from her results. **[2]**

d. Smriti first uses her readings without taking away the background, and finds a half-life longer than 2 hours. Explain why that value is too long, and whether the error would grow or shrink if the readings went on for many more hours. **[2]**