Grade 11 Physics Model Paper 1

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 2077, Grade 11 Physics (Phy. 101); 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 NEB's Grade 11 Physics paper (Phy. 101): 75 marks in 3 hours. Group A is one question of 11 multiple-choice items; groups B and C have questions of two or three parts, with the marks of each part. Questions 2 and 6 in group B and Question 11 in group C have an OR question: answer either one. Take $g = 9.8\ \mathrm{m/s^2}$ unless a question gives another value. Write your answers on paper as in the exam hall, then tap your choice in group A, open each other part's answer and give yourself the marks its scheme allows.

Group A Multiple choice — 11 marks

Question 1 — 11 × 1 = 11

Choose the correct option for each of the following questions.

a. A student writes the mass of a coin as 0.004050 kg. How many significant figures does this reading have?

(i) 3 (ii) 4 (iii) 6 (iv) 7

b. The scalar (dot) product of two vectors $\vec{A}$ and $\vec{B}$, neither of them zero, is zero. What is the angle between them?

(i) 0° (ii) 45° (iii) 90° (iv) 180°

c. The velocity–time graph of a body is a straight line parallel to the time axis, above it. What does this show?

(i) The body is at rest.
(ii) The body moves with a uniform velocity.
(iii) The body moves with a uniform acceleration.
(iv) The body moves with a uniform retardation.

d. A car goes round a roundabout at a steady 20 km/h. Which statement is true?

(i) Its velocity is constant, because its speed does not change.
(ii) It has no acceleration, because its speed does not change.
(iii) Its velocity changes, and its acceleration points to the center of the circle.
(iv) Its acceleration points along its path, in the direction it moves.

e. The acceleration due to gravity at the Earth's surface is 9.8 m/s². What is it at a height above the surface equal to the Earth's radius?

(i) 4.9 m/s² (ii) 2.45 m/s² (iii) 1.09 m/s² (iv) 9.8 m/s²

f. White light passes through a glass prism. Which color is deviated the most?

(i) Red (ii) Yellow (iii) Green (iv) Violet

g. An object is placed between a convex lens and its principal focus. What kind of image does the lens form?

(i) Real, inverted and magnified
(ii) Real, inverted and diminished
(iii) Virtual, erect and magnified
(iv) Virtual, erect and diminished

h. An object stands 20 cm in front of a concave mirror of focal length 15 cm. Where is the image, and how large is it?

(i) 8.6 cm from the mirror, virtual, 0.43 times the object
(ii) 60 cm from the mirror, virtual, 3 times the object
(iii) 60 cm in front of the mirror, real and inverted, 3 times the object
(iv) 35 cm in front of the mirror, real and inverted, 1.75 times the object

i. A glass prism has a refracting angle of 60°. Its angle of minimum deviation is 30°. What is the refractive index of the glass?

(i) 1.33 (ii) 1.41 (iii) 1.50 (iv) 1.73

j. A copper wire of resistance R is drawn out evenly until it is twice as long, keeping its volume the same. What is its resistance now?

(i) $R/2$ (ii) R (iii) $2R$ (iv) $4R$

k. To which family of fundamental particles do the electron and the neutrino belong?

(i) Quarks (ii) Leptons (iii) Baryons (iv) Mesons

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

Question 2 — 5 marks

Bibek, a fielder in a school cricket match at Tundikhel, watches the batter hit a ball of mass 160 g. The ball reaches the bat at 30 m/s and leaves it at 20 m/s straight back along the same line. The bat is in contact with the ball for 0.010 s.

a. State Newton's second law of motion, and define impulse. **[2]**

b. Calculate the average force exerted by the bat on the ball. **[2]**

c. Bibek says the bat must push the ball harder than the ball pushes the bat, because the ball turns back and the bat doesn't. Is he right? Give a reason. **[1]**

OR

Pemba is fitting a steel wire to lift loads at a building site in Lukla. A trial wire is 2.0 m long and has a cross-sectional area of 1.0 mm². He hangs a load of 20 kg from it and measures an extension of 1.96 mm.

a. State Hooke's law, and define Young's modulus. **[2]**

b. Calculate the stress and the strain in the wire, and the Young's modulus of its steel. **[2]**

c. For the real hoist, Pemba chooses a wire of four times the cross-sectional area for the same loads. Give a reason. **[1]**

Question 3 — 5 marks

Aayusha uses a 2.0 kW electric kettle to heat 1.2 kg of water from 20 °C to 100 °C in her home in Bhaktapur. (Specific heat capacity of water = 4200 J/(kg K).)

a. Hot-water bags are filled with water rather than another liquid. Why? **[1]**

b. Calculate the time the kettle takes to heat the water to 100 °C, assuming no heat is lost. **[3]**

c. Her cousin in Namche Bazaar (3440 m) heats the same amount of water from 20 °C with the same kettle. Will his water start boiling sooner or later than hers? Give a reason. **[1]**

Question 4 — 5 marks

Sonam's family runs a lodge in Jomsom. On a winter evening the inside of a glass window is at 15 °C and the outside at −5 °C. The glass is 1.5 m² in area and 4.0 mm thick. (Thermal conductivity of glass = 0.80 W/(m K).)

a. Define temperature gradient and thermal conductivity, and write the SI unit of thermal conductivity. **[3]**

b. Calculate the rate at which heat is conducted through the window. The family plans to replace it with two panes of glass with a layer of still air between them. Will this help? Give a reason. **[2]**

Question 5 — 5 marks

Early one morning in Dang, Abinash measures the pressure of the air in a car tyre as 2.0×10^5 Pa (absolute pressure) at 17 °C. After a long drive the air in the tyre is at 46 °C. Take the volume of the tyre as constant.

a. State the pressure law (Gay-Lussac's law). **[1]**

b. Calculate the pressure of the air in the tyre after the drive. **[3]**

c. Use the kinetic theory of gases to explain why the pressure rises. **[1]**

Question 6 — 5 marks

The internet reaches Nepal through optical fibers, thin strands of glass along which light is guided by total internal reflection. The glass of one fiber's core has a refractive index of 1.5.

a. Define critical angle, and state the two conditions for total internal reflection. **[2]**

b. A diamond sparkles far more than a piece of glass cut in the same shape. Why? **[1]**

c. Calculate the critical angle for light going from the fiber's glass into air. **[2]**

OR

Nischal, who is long-sighted, finds that his eye doctor's trial frame holds two thin lenses in contact: a convex lens of focal length 25 cm and a concave lens of focal length 100 cm.

a. Define the power of a lens, and write its SI unit. **[2]**

b. Why is a concave lens called a diverging lens? **[1]**

c. Calculate the power and the focal length of the combination, and say whether it is converging or diverging. **[2]**

Question 7 — 5 marks

In a physics practical, Aisha rubs a glass rod with silk, and then studies two small charged spheres: $+4.0\ \mu\text{C}$ at A and $+1.0\ \mu\text{C}$ at B, 30 cm apart in air.

a. Explain how the glass rod becomes positively charged when rubbed with silk, and what charge the silk gets. **[2]**

b. Aisha wants to place a third small charge on the line AB where the net electric force on it is zero. Find where she should put it. Does the answer depend on the size or sign of the third charge? Explain. **[3]**

Question 8 — 5 marks

The flash of Yugin's camera is powered by a 150 μF capacitor, which is charged to 300 V and then discharged through the flash tube in about 1.5 ms.

a. Define capacitance, and write its SI unit. **[2]**

b. Calculate the charge stored, the energy stored, and the average power delivered to the flash tube. Why does the camera use a capacitor instead of taking the energy straight from its battery? **[3]**

Question 9 — 5 marks

In a model of an old cathode-ray tube in Mijash's school lab, two parallel metal plates 2.0 cm apart have a potential difference of 500 V between them. (Charge of an electron = 1.6×10^{-19} C, mass = 9.1×10^{-31} kg.)

a. The electron volt is called a unit of energy, not of potential. Why? **[1]**

b. Calculate the electric field strength between the plates and the force on an electron there. **[2]**

c. An electron starts from rest at the negative plate. With what speed does it reach the positive plate? **[2]**

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

Question 10 — 8 marks

At a fun fair in Kathmandu, Sandhya's bumper car (with her in it, 200 kg) moves at 3.0 m/s into the back of her brother's car (with him, 300 kg), which is at rest. The two cars lock together and move on as one.

a. Distinguish between elastic and inelastic collisions. Which of the two quantities, momentum and kinetic energy, is conserved in each? **[3]**

b. Calculate the speed of the two cars just after the collision. **[2]**

c. How much kinetic energy is lost in the collision, and what fraction of the original is it? Show that this fraction is equal to $\frac{m_2}{m_1 + m_2}$, and say where the lost energy goes. **[3]**

Question 11 — 8 marks

Ujwal's family watches TV through a dish pointed at a geostationary satellite. ($G = 6.67 \times 10^{-11}$ N m²/kg², mass of the Earth = 6.0×10^{24} kg, radius of the Earth = 6400 km.)

a. Why must a geostationary satellite go round above the equator, from west to east? **[2]**

b. Calculate the radius of the orbit and the height of the satellite above the ground. **[3]**

c. Ujwal's friend says the satellite stays up because there is no gravity so far from the Earth. Calculate the gravitational field strength at the satellite, and use it to judge the claim. **[3]**

OR

Prarthana kicks a football from the ground at 19.6 m/s at 30° above the horizontal on the ground of her school in Pokhara. Ignore air resistance.

a. Explain why the horizontal component of the ball's velocity stays the same while the vertical component changes. **[2]**

b. Calculate the ball's time of flight, its greatest height and its horizontal range. **[3]**

c. Her coach says that a kick at 45° at the same speed would go farthest, and that a kick at 60° would land at the same spot as her 30° kick. Check both statements with calculations, and say which of the 30° and 60° kicks stays in the air longer. **[3]**

Question 12 — 8 marks

The nucleus of carbon-12 has 6 protons and 6 neutrons. Its mass is 11.99671 u. (Mass of a proton = 1.00728 u, mass of a neutron = 1.00867 u, 1 u = 931.5 MeV/c².)

a. Explain what is meant by the mass defect and the binding energy of a nucleus. Why is the binding energy per nucleon, rather than the total binding energy, used to compare how stable nuclei are? **[3]**

b. Calculate the mass defect, the binding energy and the binding energy per nucleon of carbon-12. **[3]**

c. The binding energy per nucleon is about 7.6 MeV for uranium-235 and about 8.8 MeV for iron-56. Explain why energy is released both when a uranium nucleus splits (fission) and when light nuclei such as hydrogen join (fusion). **[2]**