Grade 11 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 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. Which pair of quantities has the same dimensions?

(i) Force and power
(ii) Work and torque
(iii) Momentum and energy
(iv) Pressure and force

b. A bus brakes suddenly, and the standing passengers lurch forwards. Which idea explains this?

(i) The bus pushes them forwards as it stops.
(ii) Inertia: their bodies tend to keep moving at the speed they had.
(iii) The reaction to the braking force acts on the passengers.
(iv) Friction from the floor pushes their feet forwards.

c. A porter carries a sack on his back along a level road at a steady speed. How much work does the upward force he exerts on the sack do?

(i) mgh, where h is the height of the sack above the road
(ii) Its weight × the distance walked
(iii) Zero
(iv) It depends on how fast he walks.

d. Equal stretching forces act on a steel wire and a rubber cord of the same length and thickness. The steel stretches far less. What does this show?

(i) Rubber is more elastic than steel.
(ii) Steel has a larger Young's modulus, so it is more elastic in the physics sense.
(iii) Steel has a smaller Young's modulus than rubber.
(iv) Both have the same Young's modulus, since the forces are equal.

e. Two forces of 3 N and 4 N act on a body at right angles to each other. What is the size of their resultant?

(i) 1 N (ii) 3.5 N (iii) 5 N (iv) 7 N

f. When light passes from one medium into another, the ratio $\frac{\sin i}{\sin r}$ is a constant for the pair of media. What is this law called?

(i) Snell's law
(ii) The law of reflection
(iii) The principle of reversibility of light
(iv) Total internal reflection

g. A swimming pool looks shallower than it really is. Why?

(i) Light travels faster in water than in air.
(ii) Light from the bottom bends away from the normal as it leaves the water.
(iii) Light from the bottom bends towards the normal as it leaves the water.
(iv) Light is totally reflected at the surface of the water.

h. An object is placed 15 cm from a convex lens of focal length 10 cm. Where is the image formed?

(i) 6 cm from the lens, on the same side as the object
(ii) 25 cm from the lens, on the other side
(iii) 30 cm from the lens, on the other side
(iv) 30 cm from the lens, on the same side as the object

i. For a kind of glass, the refractive indices for violet, red and yellow light are 1.66, 1.64 and 1.65. What is its dispersive power?

(i) 0.012 (ii) 0.020 (iii) 0.031 (iv) 0.65

j. Two charges $+q$ and $-q$ are fixed a short distance apart. At the point midway between them, which statement is true?

(i) The electric field and the electric potential are both zero.
(ii) The electric potential is zero, but the electric field is not.
(iii) The electric field is zero, but the electric potential is not.
(iv) Neither the electric field nor the electric potential is zero.

k. What are the majority charge carriers in an n-type semiconductor?

(i) Electrons (ii) Holes (iii) Positive ions (iv) Protons

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

Question 2 — 5 marks

Shristi checks the equations in her physics notebook by their dimensions.

a. What are the dimensions of a physical quantity? State the principle of homogeneity of dimensions. **[2]**

b. Check whether the equation $v^2 = u^2 + 2as$ is dimensionally correct. **[2]**

c. Shristi's friend writes $s = ut + at^2$ and says it must be right, since it is dimensionally correct. Is she right? Give a reason. **[1]**

OR

On a rainy day in Ilam, rain falls vertically at 6.0 m/s, and Kushal cycles due east at 8.0 m/s.

a. Define relative velocity. Write the velocity of a body A relative to a body B in terms of their velocities. **[2]**

b. Find the speed and direction of the rain as Kushal sees it. **[2]**

c. How should he hold his umbrella to keep dry? **[1]**

Question 3 — 5 marks

A railway line in the Tarai is laid in steel rails 12 m long at 10 °C. In summer the rails can reach 45 °C. (Linear expansivity of steel = $1.2 \times 10^{-5}\ \mathrm{K^{-1}}$.)

a. Why are small gaps left between the rails when a railway line is laid? **[1]**

b. Calculate the smallest gap that must be left between two rails. **[3]**

c. A bimetallic strip of brass and iron (brass expands more) is straight at room temperature. Which way does it bend when it is cooled in a freezer? Give a reason. **[1]**

Question 4 — 5 marks

A thermometer in Nabin's school lab has its fixed points marked wrongly: it reads 5 °C in pure melting ice and 95 °C in steam above boiling water at standard pressure.

a. What is meant by thermal equilibrium? State the zeroth law of thermodynamics, and say why it is the working principle of a thermometer. **[3]**

b. Find the true temperature when this thermometer reads 41 °C. At what temperature does it read correctly? **[2]**

Question 5 — 5 marks

Saugat leaves a black iron hot plate of surface area 0.020 m² at 227 °C in a room at 27 °C. Treat it as a black body. (Stefan's constant $\sigma = 5.67 \times 10^{-8}$ W/(m² K⁴).)

a. State Stefan's law of black-body radiation. **[1]**

b. Calculate the net rate at which the hot plate loses heat by radiation. **[3]**

c. Saugat says that if he heated the plate to 454 °C, twice 227 °C, it would radiate $2^4 = 16$ times as much energy per second. Is he right? Give a reason. **[1]**

Question 6 — 5 marks

Dr. Anjali, a dentist in Biratnagar, uses a small concave mirror of focal length 10 cm to look at a tooth held 5.0 cm from it.

a. Define the principal focus and the radius of curvature of a concave mirror. **[2]**

b. Why do dentists use a concave mirror, and not a plane one? **[1]**

c. Find the position and the magnification of the image. **[2]**

OR

Swastika measures the deviation of light through a thin glass prism of refracting angle 5.0°.

a. Define the angle of deviation and the angle of minimum deviation of a prism. **[2]**

b. How does the ray travel inside a prism at minimum deviation? **[1]**

c. The refractive index of the glass is 1.50 for yellow light and 1.48 for red light. Find the deviation of each. **[2]**

Question 7 — 5 marks

A small metal sphere on an insulating stand in Sujana's school lab carries a charge of $+2.0\ \mu\text{C}$. ($k = \frac{1}{4\pi\varepsilon_0} = 9.0 \times 10^9$ N m²/C².)

a. Give two properties of electric field lines, and explain why two field lines never cross. **[2]**

b. Use Gauss's law to show that the field outside a uniformly charged sphere is the same as if all its charge were at its center. Then find the field 30 cm from the sphere's center, and say what the field is inside a hollow charged conducting sphere. **[3]**

Question 8 — 5 marks

Sangam's torch cell has an e.m.f. of 1.5 V and an internal resistance of 0.50 Ω. He connects it to a bulb of resistance 2.5 Ω.

a. Define the e.m.f. of a cell and its internal resistance. **[2]**

b. Calculate the current, the terminal p.d. and the "lost volts". Then explain why the torch grows dimmer as the cell gets old, even though its e.m.f. stays nearly 1.5 V. **[3]**

Question 9 — 5 marks

Rabina has two capacitors, of 2.0 µF and 3.0 µF, for a project.

a. Why is the total capacitance of capacitors in parallel larger than any one of them? **[1]**

b. Find the capacitance of the two in series and in parallel. **[2]**

c. She connects the two in series to a 10 V supply. Find the charge on each and the p.d. across each. Which capacitor has the larger p.d., and why? **[2]**

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

Question 10 — 8 marks

Aaryan's team slides a crate down a wooden ramp at a building site in Hetauda. The ramp makes 37° with the horizontal ($\sin 37^\circ = 0.60$, $\cos 37^\circ = 0.80$).

a. Define the angle of friction and the angle of repose. Show that the tangent of each equals the coefficient of static friction. **[3]**

b. Once the crate is moving, the coefficient of kinetic friction is 0.25. Find its acceleration down the ramp. **[2]**

c. The coefficient of static friction between the crate and the ramp is 0.50. Will the crate, placed at rest on the ramp, start to slide by itself? Find the largest angle at which the ramp could be set so that the crate stays at rest, and say whether laying a wet plank on the ramp would make this angle larger or smaller. **[3]**

Question 11 — 8 marks

A car of mass 1000 kg goes round a bend of radius 50 m on the Mugling road at 36 km/h.

a. What supplies the centripetal force on the car on a flat road, and why are roads banked at bends? **[2]**

b. Calculate the centripetal force needed on a flat road, and the least coefficient of friction between the tyres and the road for the car not to skid. **[3]**

c. Find the angle at which the bend should be banked so that a car at 36 km/h needs no friction. On a wet day, the coefficient of friction on a flat road falls to 0.40. Could a driver safely take the flat bend at 72 km/h? Show your working. **[3]**

OR

A water pump on the ground floor of Pragya's house in Lalitpur lifts 500 kg of water to a tank 20 m above it in 5.0 minutes.

a. Distinguish between conservative and non-conservative forces, with an example of each. **[2]**

b. Calculate the work done on the water and the useful power of the pump. **[3]**

c. The pump is only 70% efficient. Pragya's father wants to buy a 0.5 hp motor for it (1 hp = 746 W). Will it be powerful enough? Show your working, and say where the rest of the energy goes. **[3]**

Question 12 — 8 marks

Light from a distant galaxy contains the red line of hydrogen, which in a laboratory has a wavelength of 656.3 nm. In the galaxy's light it is measured at 669.4 nm. (Speed of light = 3.0×10^8 m/s, $H_0 = 70$ km/s per Mpc, 1 Mpc = 3.09×10^{22} m, 1 year = 3.16×10^7 s.)

a. What is the redshift of a galaxy? Explain how the redshifts of galaxies show that the universe is expanding, and state Hubble's law. **[3]**

b. Calculate the galaxy's redshift, its recessional speed and its distance. **[3]**

c. Use the Hubble constant to estimate the age of the universe in years. **[2]**