ICSE CLASS 10 EXAMINATION

SAMPLE PAPER 2 · STEP-BY-STEP SOLUTIONS & MARKING SCHEME

PHYSICS

(SCIENCE PAPER 1)

Maximum Marks: 80 · Section A (40) compulsory · Section B: any four of six questions (4 × 10 = 40). Marks for each step are shown in square brackets on the right. Parts added in the solution diagrams are drawn in red. Cartesian sign convention is used for lenses.

SECTION A (40 Marks)

Question 1 — Multiple choice [15 marks, 1 mark each]

No.	Answer	Reason
(i)	**(a)** 30°	sin r = sin 60° ÷ √3 = 0.866 ÷ 1.732 = 0.5, so r = 30°.
(ii)	**(c)** 18 J	K.E. = ½mv² = ½ × 4 × 3² = 18 J.
(iii)	**(b)** 3	M.A. = effort arm ÷ load arm = 60 ÷ 20 = 3.
(iv)	**(c)** 40 cm	f = 1 ÷ P = 1 ÷ 2.5 = 0.4 m = 40 cm.
(v)	**(c)** red	v = c ÷ μ; red light has the smallest refractive index in glass, so it travels fastest.
(vi)	**(c)** 11300 J	Q = mL = 5 × 2260 = 11 300 J.
(vii)	**(b)** amplitude	Loudness depends on the amplitude of vibration (pitch depends on frequency, quality on waveform).
(viii)	**(b)** 2 m	λ = v ÷ f = 340 ÷ 170 = 2 m.
(ix)	**(a)** (A) is true and (R) is false.	(A) is true. (R) is false: in a series circuit the current is common and the p.d. is divided in proportion to the resistances; equal p.d. is the feature of a parallel circuit.
(x)	**(c)** 3 A	I_1 = 12 ÷ 6 = 2 A and I_2 = 12 ÷ 12 = 1 A, so the main-line ammeter reads 2 + 1 = 3 A (R = 4 Ω; I = 12 ÷ 4 = 3 A).
(xi)	**(b)** 0.5 kWh	E = P × t = 0.1 kW × 5 h = 0.5 kWh.
(xii)	**(b)** generator	A generator (dynamo) works on electromagnetic induction and converts mechanical energy into electrical energy.
(xiii)	**(c)** 0.02 s	T = 1 ÷ f = 1 ÷ 50 = 0.02 s.
(xiv)	**(b)** increases by 1	In β-decay a neutron changes into a proton and an electron is emitted, so Z increases by 1.
(xv)	**(b)** protons	Isotopes have the same atomic number (the same number of protons) but different mass numbers.

Question 2 [10 marks]

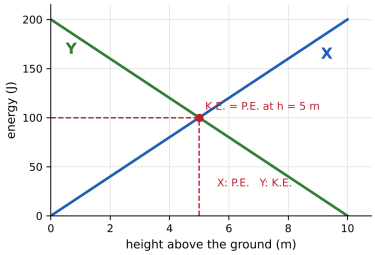
(i) (a) **4** (K.E. ∝ v², so doubling v gives 2² = 4 times). (b) **virtual**. (c) **solids** (the molecules are closest together). (d) **J kg⁻¹** (L = Q ÷ m). (e) **right** hand rule (used for generators). (f) **metal body**. [6 × 1] **[6]**

(ii) (a) Multiple reflection of sound → **1** (stethoscope). [1] **[2]**

(b) Electromagnetic induction → **2** (transformer). [1]

(iii) (a) **X is the potential energy** (it increases with height) and **Y is the kinetic energy** (it decreases as the ball gets higher; for a falling ball it increases as the height decreases). [1] **[2]**

(b) At the top (h = 10 m) the total energy is P.E. = 200 J: mgh = 200, so m = 200 ÷ (10 × 10) = **2 kg**. [1]

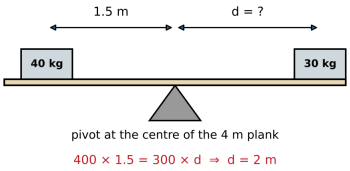


Solution to Q2(iii)

Question 3 [15 marks]

(i) (a) Moment = F × d = (40 × 10) × 1.5 = **600 N m**. [1] **[2]**

(b) For balance, 300 × d = 600, so d = **2 m** (the extreme end of the plank). [1]



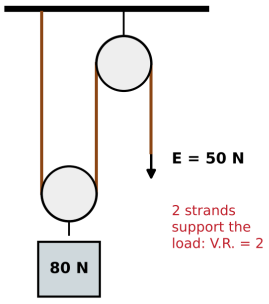
Solution to Q3(i)

(ii) (a) Height climbed = 30 × 0.2 = 6 m; W = mgh = 40 × 10 × 6 = **2400 J**. [1] **[2]**

(b) P = W ÷ t = 2400 ÷ 12 = **200 W**. [1]

(iii) (a) Two strands support the movable pulley, so V.R. = **2**. [1] **[2]**

(b) M.A. = load ÷ effort = 80 ÷ 50 = 1.6; efficiency = M.A. ÷ V.R. × 100 = (1.6 ÷ 2) × 100 = **80%**. [1]



Solution to Q3(iii)

(iv) (a) I = P ÷ V = 2200 ÷ 220 = **10 A**. [1] **[2]**

(b) Energy = 2.2 kW × (2 h × 30) = **132 kWh**. [1]

(v) (a) **Specific latent heat of fusion** is the heat energy required to change unit mass (1 g or 1 kg) of a solid into liquid at its melting point without any change in temperature. [1] **[2]**

(b) Q = mL = 20 × 2260 = **45 200 J** (released). [1]

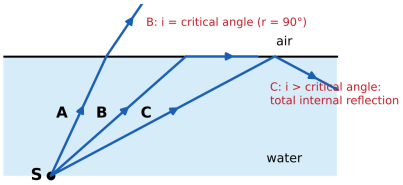
(vi) (a) **Half-life** is the time in which half of the radioactive nuclei in a sample decay (the activity or mass falls to half its value). [1] **[2]**

(b) 18 h = 3 half-lives: 80 → 40 → 20 → **10 g** remain. [1]

(vii) (a) Ray C has an angle of incidence greater than the critical angle, so it undergoes **total internal reflection**. [1] **[3]**

(b) The **critical angle** (the refracted ray grazes the surface, r = 90°). [1]

(c) sin C = 1 ÷ μ = 1 ÷ (4/3) = 0.75, so **C ≈ 49°** (48.6°). [1]



Solution to Q3(vii)

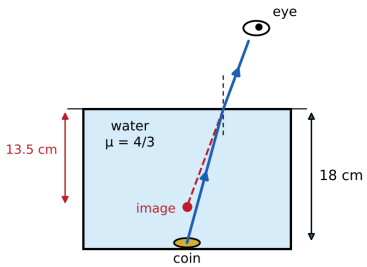
SECTION B (40 Marks) — any four questions

Question 4 [10 marks]

(i) (a) Apparent depth = real depth ÷ μ = 18 ÷ (4/3) = **13.5 cm**. [1] **[3]**

(b) Raised by 18 − 13.5 = **4.5 cm**. [1]

(c) **Refraction** of light: rays from the coin bend away from the normal on leaving water, so they appear to come from a shallower point. [1]

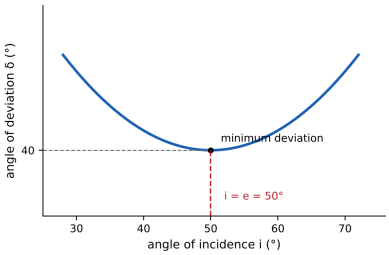


Solution to Q4(i)

(ii) (a) At minimum deviation the ray passes symmetrically, so **e = i = 50°**. [1] **[3]**

(b) δ = i + e − A, so 40 = 50 + 50 − A and the angle of prism **A = 60°**. [1]

(c) μ = sin[(A + δ) ÷ 2] ÷ sin(A ÷ 2) = sin 50° ÷ sin 30° = 0.766 ÷ 0.5 = **1.53**. [1]



Solution to Q4(ii)

(iii) Given: h = +5 cm, u = −15 cm, f = −10 cm (concave lens). **[4]**

(a) 1/v = 1/f + 1/u = −1/10 − 1/15 = −5/30, so v = **−6 cm** (6 cm on the same side as the object). [1]

(b) m = v ÷ u = (−6) ÷ (−15) = **+0.4**. [1]

(c) h′ = m × h = 0.4 × 5 = **2 cm** (erect). [1]

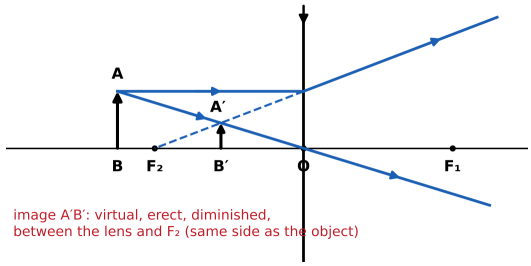
(d) The image is **virtual, erect and diminished**. [1]

Question 5 [10 marks]

(i) Ray 1: from the top A of the object, a ray parallel to the principal axis is refracted so that it appears to diverge from the principal focus F_2 on the same side as the object. [1] **[3]**

Ray 2: a ray from A through the optical centre O passes undeviated; the two diverging rays, produced backwards, meet at A′. [1]

Image A′B′ is **virtual, erect, diminished and between F_2 and the lens (on the same side as the object)**. [1]

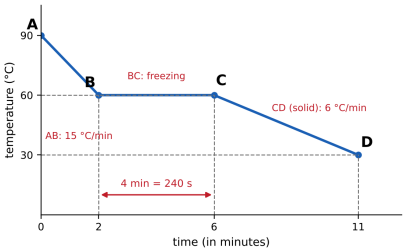


Solution to Q5(i)

(ii) (a) The temperature stays constant at 60 °C during BC: **freezing point = 60 °C**. [1] **[3]**

(b) For AB (liquid): time = 2 min = 120 s, heat lost = 50 × 120 = 6000 J, fall in temperature = 90 − 60 = 30 °C; c = Q ÷ (mΔT) = 6000 ÷ (200 × 30) = **1 J g⁻¹ °C⁻¹**. [1]

(c) For BC: time = (6 − 2) = 4 min = 240 s; heat lost = 50 × 240 = 12 000 J; L = Q ÷ m = 12 000 ÷ 200 = **60 J g⁻¹**. [1]



Solution to Q5(ii)

(iii) (a) Heat gained by water = mcΔT = 150 × 4.2 × (25 − 20) = **3150 J**. [1] **[4]**

(b) **Principle of calorimetry**: heat lost by the hot body = heat gained by the cold body (no heat is lost to the surroundings). [1]

(c) 100 × c × (100 − 25) = 3150, so 7500 c = 3150 and **c = 0.42 J g⁻¹ °C⁻¹**. [1]

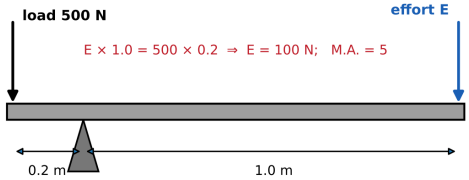
(d) The wood and cotton are bad conductors of heat; they reduce the loss of heat from the calorimeter to the surroundings. [1]

Question 6 [10 marks]

(i) (a) The fulcrum lies between the load and the effort: a **class I lever**. [1] **[3]**

(b) By the principle of moments: E × 1.0 = 500 × 0.2, so **E = 100 N**. [1]

(c) M.A. = load ÷ effort = 500 ÷ 100 = **5**; V.R. = effort arm ÷ load arm = 1.0 ÷ 0.2 = **5** (an ideal lever, efficiency 100%). [1]

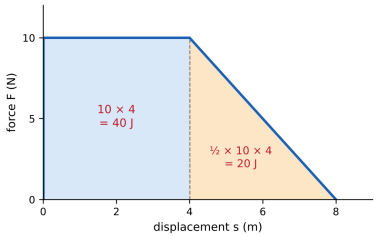


Solution to Q6(i)

(ii) (a) The force is constant: W = F × s = 10 × 4 = **40 J** (area of the rectangle). [1] **[3]**

(b) The force falls uniformly to zero: W = area of the triangle = ½ × 4 × 10 = **20 J**. [1]

(c) Total work = 40 + 20 = **60 J**; P = W ÷ t = 60 ÷ 12 = **5 W**. [1]



Solution to Q6(ii)

(iii) m = 200 g = 0.2 kg, h = 0.45 m. **[4]**

(a) P.E. at A = mgh = 0.2 × 10 × 0.45 = **0.9 J**. [1]

(b) By conservation of mechanical energy, K.E. at B = P.E. lost = **0.9 J**. [1]

(c) ½ mv² = 0.9, so v² = (2 × 0.9) ÷ 0.2 = 9 and **v = 3 m s⁻¹**. [1]

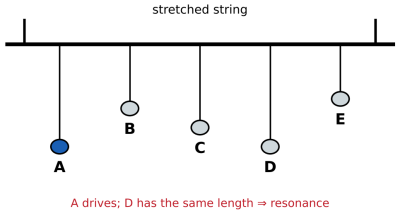
(d) The **potential energy changes into kinetic energy** as the bob goes from A to B. [1]

Question 7 [10 marks]

(i) (a) Pendulum **D**: it has the same length (the same natural frequency) as A. [1] **[3]**

(b) **Resonance**: the periodic force from A has the same frequency as the natural frequency of D. [1]

(c) **Forced vibrations** (of small amplitude, with the frequency of A and not their own natural frequency). [1]

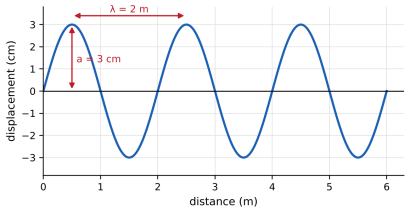


Solution to Q7(i)

(ii) (a) Amplitude = maximum displacement = **3 cm**. [1] **[3]**

(b) The distance between two successive crests is 2 m: **λ = 2 m**. [1]

(c) f = v ÷ λ = 340 ÷ 2 = **170 Hz**. [1]



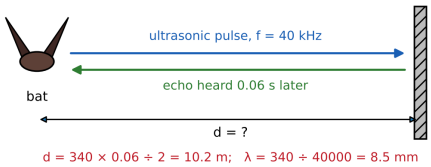
Solution to Q7(ii)

(iii) (a) The sound travels to the wall and back in 0.06 s: d = (340 × 0.06) ÷ 2 = **10.2 m**. [1] **[4]**

(b) λ = v ÷ f = 340 ÷ 40 000 = 0.0085 m = **8.5 mm**. [1]

(c) The frequency (40 kHz) is above 20 000 Hz, the upper limit of human hearing, so it is ultrasound. [1]

(d) **SONAR** (also RADAR-type echo sounders). [1]



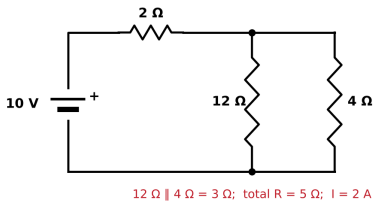
Solution to Q7(iii)

Question 8 [10 marks]

(i) (a) 1/R = 1/12 + 1/4 = 4/12, so R_p = **3 Ω**. [1] **[3]**

(b) Total R = 2 + 3 = 5 Ω; I = V ÷ R = 10 ÷ 5 = **2 A**. [1]

(c) The p.d. across the parallel part = 2 × 3 = 6 V; current in 12 Ω = 6 ÷ 12 = **0.5 A**. [1]

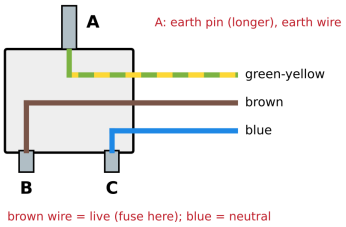


Solution to Q8(i)

(ii) (a) A is the **earth pin**, connected to the **green-yellow (earth) wire**. [1] **[3]**

(b) The **brown wire** is the live wire (connected to pin B). The fuse is placed in the **live wire**. [1]

(c) The longer and thicker earth pin enters the socket first, so the body of the appliance is earthed before the live pin makes contact; it also opens the safety shutters of the live and neutral sockets. [1]



Solution to Q8(ii)

(iii) (a) I = V ÷ R = 220 ÷ 55 = **4 A**. [1] **[4]**

(b) P = VI = 220 × 4 = **880 W**. [1]

(c) Time = 6 × 60 = 360 s; H = P × t = 880 × 360 = **316 800 J**. [1]

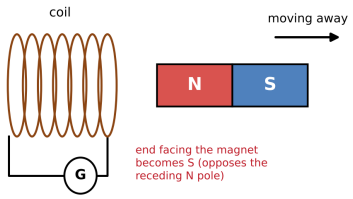
(d) E = 0.88 kW × (6 ÷ 60) h = **0.088 kWh**. [1]

Question 9 [10 marks]

(i) (a) **Electromagnetic induction**. [1] **[3]**

(b) The N-pole is moving away, so by **Lenz's law** the induced current opposes this motion by attracting the magnet: the end facing the magnet becomes a **south pole**. [1]

(c) Any two: move the magnet faster; use a stronger magnet; increase the number of turns of the coil. [1]

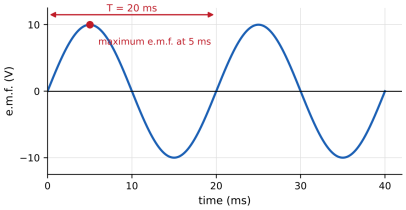


Solution to Q9(i)

(ii) (a) The peak value of the e.m.f. = **10 V**. [1] **[3]**

(b) T = 20 ms = 0.02 s, so f = 1 ÷ T = 1 ÷ 0.02 = **50 Hz**. [1]

(c) The direction reverses twice in each cycle: 2 × 50 = **100 times**. [1]



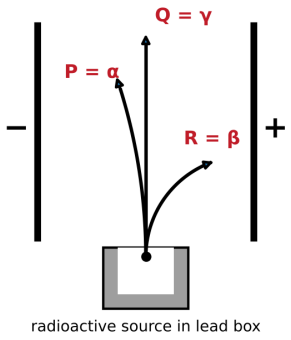
Solution to Q9(ii)

(iii) (a) P is the **α-particle (helium nucleus)**: it is positively charged, so it is attracted towards the negative plate (and deflected only a little because it is heavy). [1] **[4]**

(b) Q is the **γ-radiation**: it is not deflected as it carries no charge. [1]

(c) R is the **β-radiation**: it is attracted towards the positive plate and deflected through a large angle, so it is a stream of fast moving **electrons**. [1]

(d) The **α-particles** have the highest ionising power. [1]



Solution to Q9(iii)

Marks summary	
Section A: Q1 (15) + Q2 (6 + 2 + 2 = 10) + Q3 (2 × 6 + 3 = 15)	**40**
Section B: any four of Q4 – Q9 (3 + 3 + 4 = 10 marks each)	**40**
Total	**80**