ICSE CLASS 10 · PHYSICS

Chapter 2 : WORK, ENERGY AND POWER

STEP-BY-STEP SOLUTIONS & MARKING SCHEME (40 MARKS)

Maximum Marks: 40 · Section A (20) compulsory · Section B: any two of three questions (2 × 10 = 20) · g = 10 m s⁻²

Marks for each step are shown in square brackets on the right.

SECTION A (20 Marks)

Question 1 — Multiple choice [8 marks, 1 mark each]

No.	Answer	Reason
(i)	**(a)** joule	The S.I. unit of work (force × displacement = N m) is the joule (J).
(ii)	**(c)** 90°	W = F S cos θ; for θ = 90°, cos 90° = 0, so W = 0.
(iii)	**(d)** 3.6×10^6 J	1 kWh = 1000 W × 3600 s = 3.6×10^6 J.
(iv)	**(b)** 25 J	K = ½ m v² = ½ × 2 × (5)² = 25 J.
(v)	**(c)** Both (A) and (R) are true, and (R) is the correct explanation for (A).	(A) is true and (R) is true. The load moves horizontally while gravity acts vertically downwards, so θ = 90° and the work done against gravity is zero; (R) explains (A).
(vi)	**(d)** 500 W	P = mgh ÷ t = (100 × 10 × 10) ÷ 20 = 500 W.
(vii)	**(a)** four times	K ∝ v², so doubling the speed makes K = (2)² = 4 times.
(viii)	**(c)** sound to electrical	A microphone converts sound energy into electrical energy (signals).

Question 2 [6 marks]

(a) **Power** is the rate of doing work: P = W ÷ t. [1] **[2]**

S.I. unit: **watt (W)**, where 1 W = 1 J s^{-1}. Relation: **1 H.P. = 746 W**. [½ + ½]

(b) Work done = Force × component of displacement in the direction of force, i.e. **W = F S cos θ**. [1] **[2]**

W = 20 × 3 × cos 60° = 20 × 3 × ½ = **30 J**. [1]

(c) Any two (1 mark each): **[2]**

• Potential energy is due to the position or configuration of a body; kinetic energy is due to its state of motion.

• Potential energy does not depend on the speed of the body; kinetic energy depends on its speed (K = ½ m v²).

• Potential energy can change only into kinetic energy; kinetic energy can change into any other form.

• Potential energy equals the work done in bringing the body to its state; kinetic energy equals the work the body can do before coming to rest.

Question 3 [6 marks]

(a) Height climbed h = 25 × 16 cm = 400 cm = 4 m. Force of gravity = mg = 40 × 10 = 400 N. **[3]**

(i) Work done = mgh = 400 × 4 = **1600 J**. [1½]

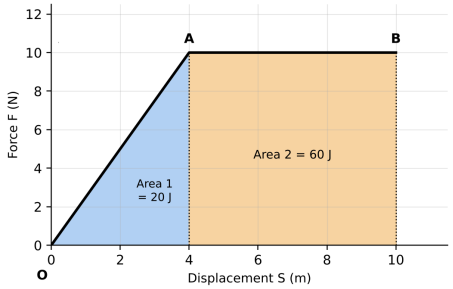
(ii) Power = W ÷ t = 1600 ÷ 10 = **160 W**. [1½]

(b) Work done by a variable force = area under the force–displacement graph. **[3]**

(i) OA is a triangle: area = ½ × base × height = ½ × 4 × 10 = **20 J**. [1]

(ii) AB is a rectangle: area = 6 × 10 = **60 J**. [1]

(iii) Total work = 20 + 60 = **80 J**. [1]



Solution to Q3(b): work = area under the graph

SECTION B (20 Marks) — any two questions

Question 4 [10 marks]

(a) (i) One **kilowatt hour** is the energy spent (or work done) by a source of power 1 kW in 1 hour. [1] **[3]**

(ii) (1) Energy = power × time = 2 kW × 5 h = **10 kWh**. [1]

(2) 1 kWh = 3.6×10^6 J, so 10 kWh = $10 \times 3.6 \times 10^6$ = **3.6×10^7 J**. [1]

(b) Let a body of mass m move with velocity v. It is brought to rest by a constant retarding force F, producing a retardation a, and travels a distance S before stopping. **[3]**

Kinetic energy K = work done by the retarding force in stopping the body = F × S. [1]

F = m a, and from $v^2 = u^2 + 2aS$ with u = v, final velocity 0 and acceleration −a: $0 = v^2 - 2aS \rightarrow S = v^2 \div 2a$. [1]

K = m a × $v^2 \div 2a$ = **½ m v^2**. [1]

(c) (i) Work done by the force = F × AB = 150 × 4 = **600 J**. [1] **[4]**

(ii) Height gained h = BC = 2 m. Gain in P.E. = mgh = 20 × 10 × 2 = **400 J**. [1]

(iii) The block moves at constant speed, so its kinetic energy does not change. Work done against friction = 600 − 400 = **200 J**. [1]

(iv) Work against friction = f × AB → 200 = f × 4 → f = **50 N**. [1]

Question 5 [10 marks]

(a) **Principle of conservation of energy:** energy can neither be created nor destroyed; it can only change from one form to another. [1] **[3]**

At the maximum height the K.E. is zero, so the initial K.E. is completely changed into P.E.: ½ m v^2 = m g h. [1]

h = $v^2 \div 2g$ = $(10)^2 \div (2 \times 10)$ = **5 m**. (Check: ½ × 0.5 × 100 = 25 J = 0.5 × 10 × 5.) [1]

(b) (i) At the extreme position B the bob is momentarily at rest, so K.E. = 0 and P.E. = mgh = 0.4 × 10 × 0.2 = 0.8 J. Total mechanical energy = **0.8 J** (constant throughout). [1] **[3]**

(ii) At A, P.E. = 0, so all the energy is kinetic: ½ m v^2 = 0.8 → ½ × 0.4 × v^2 = 0.8 → v^2 = 4 → **v = 2 m s^{-1}**. [1]

(iii) At D the height above A is 0.1 m: P.E. = 0.4 × 10 × 0.1 = **0.4 J**; K.E. = total − P.E. = 0.8 − 0.4 = **0.4 J**. [1]

(c) (i) P.E. at A = mgh = 2 × 10 × 20 = **400 J**. [1] **[4]**

(ii) The track is smooth, so the total energy stays 400 J. P.E. at B = 2 × 10 × 15 = 300 J, so K.E. at B = 400 − 300 = **100 J**. [1]

½ m v² = 100 → ½ × 2 × v² = 100 → **v = 10 m s⁻¹**. [1]

(iii) At C (ground) all the P.E. has changed into K.E. = 400 J: ½ × 2 × v² = 400 → v² = 400 → **v = 20 m s⁻¹**. [1]

Question 6 [10 marks]

(a) Given: m = 20 g = 0.02 kg, v = 300 m s⁻¹, penetration S = 0.3 m. **[3]**

(i) K.E. = ½ m v² = ½ × 0.02 × (300)² = 0.01 × 90000 = **900 J**. [1]

(ii) Work done by the resistive force = initial K.E.: F × S = 900 → F × 0.3 = 900 → F = **3000 N**. [2]

(b) Power = Force × speed, i.e. **P = F × v**. [1] **[3]**

(i) P = 250 × 12 = **3000 W** (3 kW). [1]

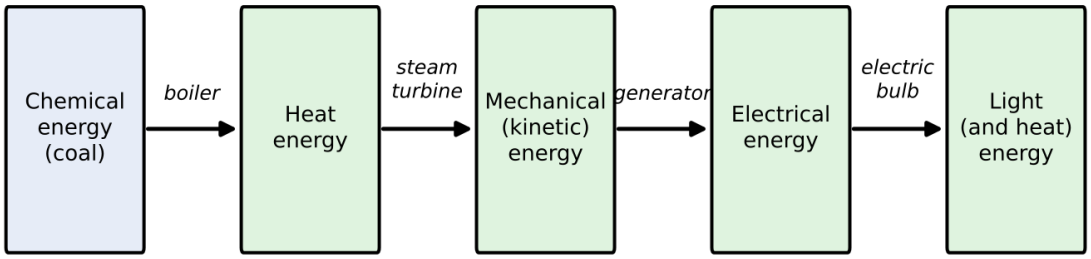
(ii) Work done in 2 min = P × t = 3000 × (2 × 60) = 3000 × 120 = **3.6 × 10⁵ J**. [1]

(c) P = **heat energy** (the burning coal heats water in the boiler and produces steam). [1] **[4]**

Q = **mechanical (kinetic) energy** (the steam turns the turbine). [1]

R = **electrical energy** (the generator converts the rotation into electricity). [1]

S = **light (and heat) energy** (the electric bulb glows). [1]



Solution to Q6(c)

Marks summary	
Section A: Q1 (8) + Q2 (3 × 2 = 6) + Q3 (2 × 3 = 6)	**20**
Section B: any two of Q4 – Q6 (10 marks each)	**20**
Total	**40**