SECTION A

Answer questions 1–20 on the answer sheet.

1. C
2. D
3. D
4. B
5. B
6. B
7. D
8. E
9. A
10. A
11. D
12. E
13. E
14. D
15. E
16. A
17. C
18. D
19. B
20. D

1 mark each

SECTION B

Marks

21. (*a*) (i) Steady — Steady
Constant speed (1 or 0) **OR** Constant velocity
or speed of 9 m/s

(ii) Steady
constant ($\frac{1}{2}$) deceleration ($\frac{1}{2}$) — Slowing down
or constant acceleration — **OR** Speed decreases = $\frac{1}{2}$

NOTE: First $\frac{1}{2}$ mark depends on second word **2**

(*b*) $a = \frac{v-u}{t}$ ($\frac{1}{2}$)

$= \frac{9-0}{20}$ ($\frac{1}{2}$)

$= 0{\cdot}45\ \text{m/s}^2$ ($\frac{1}{2}$) ($\frac{1}{2}$) **2**

(*c*) d = Area under graph ($\frac{1}{2}$)

$= \frac{1}{2} \times 20 \times 9$ ($\frac{1}{2}$) + 40×9 ($\frac{1}{2}$) + $\frac{1}{2} \times 15 \times 9$ ($\frac{1}{2}$)

=517·5 m ($\frac{1}{2}$) ($\frac{1}{2}$)

517·5 m 518 m 520 m
all acceptable **3**

(*d*) Gravitational Force ($\frac{1}{2}$) **OR** weight
is balanced by (1)
(Force of) Friction ($\frac{1}{2}$)
] Independent Marks **2**

(9)

Notes

(*c*) If d = *vt* method used, this is only correct for 2nd part of distance
ie $40 \times 9 = 360$ m Award $\frac{1}{2}$ mark.

(*c*) If area method used deduct $\frac{1}{2}$ mark. for **Arith** slip.

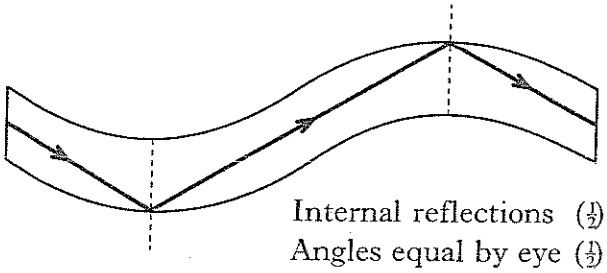
Marks

22. (*a*) (i) $F = 4 \times 170$
$= 680\,\text{kN}$ ($\frac{1}{2}$) ($\frac{1}{2}$)

(ii) $F = ma$ ($\frac{1}{2}$)
$= 185\,000 \times 3{\cdot}2$ ($\frac{1}{2}$)
$= 592\,000\,(\text{N})$ ($\frac{1}{2}$)

Friction Force $= 680\,000 - 592\,000$ ($\frac{1}{2}$)
$= 88\,000\,\text{N}$ ($\frac{1}{2}$) ($\frac{1}{2}$) 4

(*b*) (i) (A)



Internal reflections ($\frac{1}{2}$)
Angles equal by eye ($\frac{1}{2}$)

(B) Total internal ($\frac{1}{2}$) reflection ($\frac{1}{2}$)

(ii) $t = \frac{d}{v}$ ($\frac{1}{2}$)

$= \frac{62}{2 \times 10^8}$ ($\frac{1}{2}$)

$= 3{\cdot}1 \times 10^{-7}\ \text{s}$ ($\frac{1}{2}$) ($\frac{1}{2}$) 4

(8)

Notes

(*a*) (ii) 592 000 N for final answer with no working = 1½ marks
592 000 for final answer with no working = 1 mark.

(*b*) (i) (A) Accept candidate's version of copied diagram of fibre unless outrageously different
then apply mark scheme.

Marks

23. (*a*) $\omega = mg$ $(\frac{1}{2})$ Accept 9·8 N/kg

$= 90 \times 10$ $(\frac{1}{2})$

$= 900\,N$ $(\frac{1}{2})$ $(\frac{1}{2})$ **2**

(*b*) (i) $Ep = mgh$ $(\frac{1}{2})$

$= 3000 \times 90 \times 10 \times 400$ $(\frac{1}{2})$

$= 1{\cdot}08 \times 10^9\,J$ $(\frac{1}{2})$ $(\frac{1}{2})$

(ii) $P_{out} = \frac{E}{t}$ $(\frac{1}{2})$

$= \frac{1{\cdot}08 \times 10^9}{3600}$ $(\frac{1}{2})$

$= 3 \times 10^5\,(W)$ $(\frac{1}{2})$

$$\%\ \text{efficiency} = \frac{P_{out}}{P_{in}} \times 100 \quad (\tfrac{1}{2})$$

$$67{\cdot}5 = \frac{3 \times 10^5}{P_{in}} \times 100 \quad (\tfrac{1}{2})$$

$$P_{in} = 4{\cdot}44 \times 10^5\ W \quad (\tfrac{1}{2})$$

5

(7)

$4 \times 10^5\,W$ $4{\cdot}4 \times 10^5\,W$ $4{\cdot}44 \times 10^5\,W$ $4{\cdot}444 \times 10^5\,W$
All acceptable

Notes

(*b*) (i) Calculation for one skier only ($Ep = 3{\cdot}6 \times 10^5\,J$) gives $1\frac{1}{2}$ out of 2.

(*b*) (ii) Can be done using energy instead of power

$\%\ \text{eff} = \frac{E_{out}}{E_{in}} \times 100$ could get formula $\frac{1}{2}$

If **correct** energy calculation stops at $E_{in} = 1{\cdot}6 \times 10^9\,J$ give $1\frac{1}{2}$ out of 3.

Final answer—deduct $\frac{1}{2}$ if **not** watts.

Marks

24. (*a*) $I = \frac{Q}{t}$ (½) ($I = \frac{c}{t}$ OK if rest is correct)

$= \frac{300}{0{\cdot}12}$ (½)

$= 2500$ A (½) (½) 2

(*b*) Total Resistance $= 50 \times 0{\cdot}08$ (½)

$= 4(\Omega)$ (½)

$P = I^2R$ (½) **OR** $V = IR$ (½ both equations)

$= 2500^2 \times 4$ (1) $= 2500 \times 4$ (½)

$= 2{\cdot}5 \times 10^7$ W (½) $= 10\,000$ V

$P = IV$

$= 2500 \times 10\,000$ (½)

$= 2{\cdot}5 \times 10^7$ W (½) 3

(*c*) (i) $E = Pt$ (½)

$= 2{\cdot}5 \times 10^7 \times 0{\cdot}12$ (½)

$= 3 \times 10^6$ (J) (½)

$\Delta t = \frac{E_H}{cm}$ (½)

$= \frac{3 \times 10^6}{385 \times 100}$ (½)

$= 77{\cdot}9$ °C (½)

(ii) No loss of heat (energy) (½) to surroundings (½) 4

(9)

Notes

(*b*) Carry (*a*) → (*b*) R value → (*b*) P value even if answer not 25 MW.

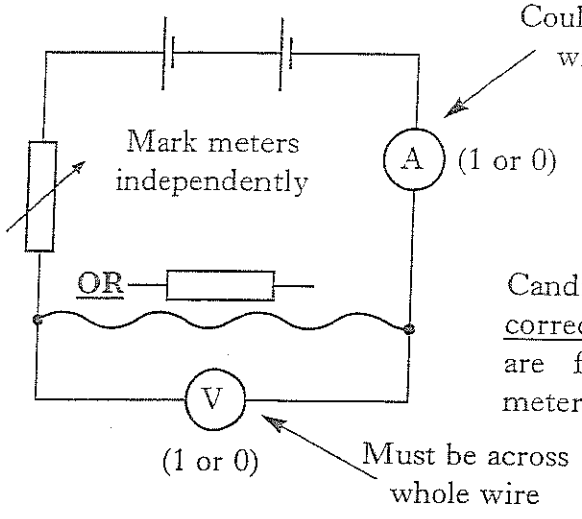
(*c*) (i) If 25 MW not used then max of 2 out of 3.

Using $\Delta T = \frac{E_H}{cm} = \frac{25 \times 10^6}{385 \times 100} = 649$ °C gets ½ out of 3.

(*c*) (ii) All electrical energy converted to heat (energy) (½) in rod (½)
Temp rise not sufficient to reach m.pt. of copper (½)

Marks

25. (*a*)



Candidates must use the correct symbols. The marks are for the placing of the meters.

2

(*b*) (i) Use variable resistor (to change current in circuit) (1)
Take voltmeter and ammeter readings (½) **OR** voltage + current readings
For each setting of the variable resistor (½)

(ii) $R = \frac{V}{I}$ (½)

$= \frac{4}{1}$ (1) **OR** any other correct combination of V + I.

$= 4\ (\Omega)$ (½)

R of one metre $= \frac{4}{0{\cdot}2}$

$= 20\ \Omega$ (½) (½)

5

(*c*) $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$ (½)

$\frac{1}{R} = \frac{1}{2} + \frac{1}{6}$ (½)

$R = 1{\cdot}5\Omega$ (½) (½)

$R_T = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{2} + \frac{1}{6} = 0{\cdot}67\Omega$ 0 marks

$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{2} + \frac{1}{6} = 0{\cdot}67\Omega$ 1 mark

$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{2} + \frac{1}{6} = \frac{2}{3} + \frac{3}{2} = 1{\cdot}5\Omega$ 1½ marks

2

(9)

Notes

(*b*) (i) Last ½ mark is for some indication of more than one reading
"Adjust variable resistor" ⇒ last ½ mark + first 1 mark
Voltage "through" loses middle ½ mark
"Adjust lab pack to get different current & voltage readings" 1 mark.

Marks

26. (*a*) (i) A helium (½) nucleus (½)
or 2 Protons + 2 Neutrons (1)

(ii) Removal of electrons (½) from atom (½)
OR addition OR to leave ion

(iii) α is much more ionising than β or γ (1)
OR α is less penetrating than β or γ (1)

(iv) C (1)
Because other two have very short half-lives (1) 5

(*b*) (i) A resistor **NOT** variable resistor (1)

(ii) V across resistor = 9 – 1·9 (½)
= 7·1 (V) (½)

$R = \frac{V}{I}$ (½)

$= \frac{7 \cdot 1}{20 \times 10^{-3}}$ (½) (½)

$= 355\,\Omega$ 4

(9)

Notes

(*a*) (ii) If charge of ion is specified it **must** be correct.

(*a*) (iii) There must be a **comparison** between α and β, γ.

(*a*) (iv) Any indication of longer time, greater length of use etc qualifies for second mark.
Second mark only available following C for first mark.

(*b*) (ii) Voltage must be 7·1 V
Otherwise ½ formula mark only.
(Only exception is a clear arith. slip trying to get 7·1 V)

Marks

27. (*a*) (i) (n-channel enhancement) MOSFET (1)

(ii) Voltage divider (1)
or potential divider **2**

(*b*) (i) 2·0 V Range 2·0 – 2·1 V (1) (½) unit deduction

(ii) $V_1 = \left(\frac{R_1}{R_1 + R_2}\right) \times Vs$ (½)

$2 = \left(\frac{R_1}{R_1 + 20}\right) \times 9$ (½)

$R_1 = 5 \cdot 71\,k\Omega$ (½) (½) **3**

OR increases

(*c*) In darkness the resistance of LDR = 10kΩ (1)] Independent
Voltage across LDR is greater than 2 V (1)] marks
MOSFET will conduct (1)]
OR be switched on **3**

(8)

Notes

(*a*) (i) Not transistor
Be sympathetic to MOSPHET
Be sympathetic to (slight) variations on n-channel enhancement.

(*b*) (ii) Version $\frac{V_1}{V_2} = \frac{R_1}{R_2}$ (½)

$\frac{2}{7} = \frac{R_1}{20}$ (½)

$R_1 = 5 \cdot 71\,k\Omega$ (½) (½)

(*b*) (i) + (*c*) **Must** match

Marks

28. (*a*) 3×10^8 m/s (1) ($\frac{1}{2}$) unit deduction 1

(*b*) $\lambda = \frac{v}{f}$ ($\frac{1}{2}$)

$= \frac{3 \times 10^8}{4 \cdot 6 \times 10^{14}}$ ($\frac{1}{2}$)

$= 6 \cdot 52 \times 10^{-7}$ (m) (1) For those with wrong speed

Light is red (1)

Note: Red on its own = zero 3

(4)

Notes

(*b*) There **must** be a complete calculation with answer before candidate can choose a colour.

(*b*) Allow frequency calculation from each wavelength to find $4 \cdot 6 \times 10^{14}$ Hz.

Marks

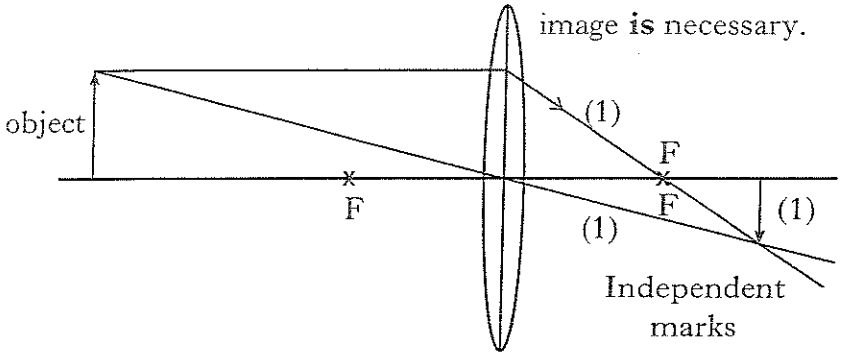
29. (*a*) $P = \frac{1}{f}$ ($\frac{1}{2}$)

Non use of metres for f loses $\frac{1}{2}$ mark.

$= \frac{1}{0{\cdot}03}$ ($\frac{1}{2}$)

$= 33$ D ($\frac{1}{2}$) ($\frac{1}{2}$) 2

(*b*) (i)



Arrows on rays not necessary.
One downwards arrow on image **is** necessary.

Independent marks

(ii) Any **two** from
Image is smaller (1)
Image is inverted (1)
Laterally inverted (or reversed) 5

(*c*) 30 mm (1) **OR** one focal length

Because light will be <u>focused</u> at <u>focal point</u> (1)
or <u>focused</u> at one focal length
or <u>focused</u> at <u>principal focus</u>

Note: The two marks are independent. 2

(9)

Notes

(*b*) (i) Object must be U > 2*f* but diagram needn't be exactly to scale
(If U < 2*f* then deduct 1 mark)

(*b*)(i) → (*b*)(ii) **must** be consistent with candidates image **but** if no image shown then start remarking at (*b*)(ii)

Marks

30. (*a*) Nucleus fissions (1) **OR** nucleus splits (**not** atom)
Release of neutrons ($\frac{1}{2}$) and energy ($\frac{1}{2}$) **2**

(*b*) Control rods absorb fewer neutrons (1)
More fissions take place (1)
Increase in temperature of coolant **OR** hotter (1)
] Independent marks

Note: "There are more neutrons" will get half mark in place of first full mark.

3

(*c*)

$$D = \frac{E}{m} \quad (\tfrac{1}{2})$$

$$= \frac{8{\cdot}4\times10^{-3}}{70} \quad (\tfrac{1}{2})$$

$$= 1{\cdot}2\times10^{-4}\ (\text{Gy}) \quad (\tfrac{1}{2})$$

$$Q = \frac{H}{D} \quad (\tfrac{1}{2})$$

$$= \frac{336\times10^{-6}}{1{\cdot}2\times10^{-4}} \quad (\tfrac{1}{2})$$

$$= 2{\cdot}8 \quad (\tfrac{1}{2})$$

Note: Deduct half mark if unit given

3

(8)

[END OF MARKING INSTRUCTIONS]

Notes

(*c*) Very common:-

$$Q = \frac{H}{D} = \frac{336\times10^{-6}}{8{\cdot}4\times10^{-3}} = 0{\cdot}04$$

gets formula $\frac{1}{2}$ mark **only**.