M1.(a) Principal focus is the point on the principal axis through which rays which were parallel to the principal axis pass after refraction by the lens ✓

Allow suitable labelled diagram

1

Power is reciprocal of focal length measured in m ✓

Allow 1 / f measured in m

1

(b) First correct ray ✓

1

Second correct ray with labelled image ✓

1

(c) Myopia or short sight ✓

1

(d) 1 / -0.33 = 1 / 0.25 + 1 / *v* ✓

1

v=(-)0.14 m ✓

1

(e) Cones active / simulated ✓

1

Cones stimulated by images must be separated by at least 1 unstimulated cone ✓

1

[9]

M2.(a) At 1Hz, individual flashes of light seen ✓

At some frequencies the flashes appear to join to form continuous light so that no flashing seen at 40Hz ✓

Process is called persistence of vision ✓

Need reference to change from flash to continuous around a given frequency

Allow 'sight' for 'vision'

3

(b) (i) $(1 / f = 1 / u + 1 / v)$ $1.75 = 1 / 0.250 + 1 / v$ ✓

v = (-) 44.4 cm ✓ 3 sig figs ✓

Sig fig mark stands alone. Allow 'x' for 'v'

3

(ii) This is the (defective eye's) unaided near point ✓

Allow uncorrected near point

1

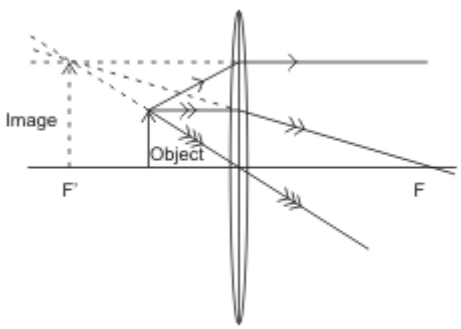
(c) Long sight / presbyopia / hypermetropia ✓

1

(d) 1 correct ray ✓

2nd correct ray with labelled image and foci ✓

Which refers to a virtual image

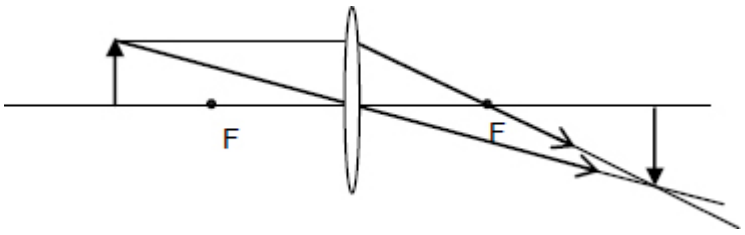


2

[10]

M3. (a) (i) Two correct rays, one through marked focal point. ✓

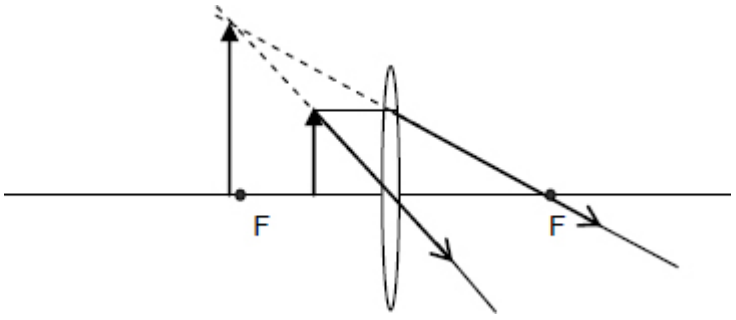
to form a magnified real image ✓



2

(ii) Two correct rays ✓

to form virtual image ✓



2

(b) (i) use of $1/f = 1/u + 1/v$

to give $1/145 = 1/112 + 1/v$ ✓

and $v = -492$ mm ✓

3 sf ✓

3

(ii) virtual, magnified, upright ✓

1

[8]