

Answer the questions in the spaces provided on the question sheets. If you run out of room for an answer, continue on a separate sheet of paper.

1. Write a Haskell function to add the first  $n$  odd numbers of a list, using only the following functions: `sum`, `filter`, `even`, `not` and `take`. The function signatures are given below.

```
sum :: Integral a => [a] -> a
filter :: (a -> Bool) -> [a] -> [a]
even :: Integral a => a -> Bool
not :: Bool -> Bool
take :: Integral -> [a] -> [a]
```

2. Consider the following functions:

$$f : \mathbb{R} \rightarrow \mathbb{R}. f(x) = x^2$$

$$g : \mathbb{Z} \rightarrow \mathbb{R}. g(x) = \frac{x}{2}$$

$$h : \mathbb{R} \rightarrow \mathbb{Z}. h(x) = \lceil x \rceil$$

What will be the definition of the following function compositions

(a)  $(f \circ g)$

(b)  $(f \circ h)$

(c)  $(h \circ g \circ h \circ f)$

Use your definitions to evaluate the following function compositions:

(d)  $(f \circ g)(1)$

(e)  $(f \circ h)(3.5)$

(f)  $(h \circ g \circ h \circ f)(\sqrt{3})$

For each of the following functions, indicate whether the function has a well-defined inverse. If the inverse is well-defined, give the input/output relationship.

(g)  $f$

(h)  $g$

(i)  $(g \circ f)$